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No. 1

A NEW *BERINGIUS* FROM THE PACIFIC NORTHWEST WITH COMMENTS ON CERTAIN DESCRIBED FORMS

By ALLYN G. SMITH¹

During the last year and a half more than a dozen specimens of a large *Beringius* have been obtained from Mr. Everett C. Stiles of Bellingham, Washington; these were taken by trawl fishermen operating off the Washington coast. Loan of these to the California Academy of Sciences for study has prompted a review of available specimens under the names *Beringius crebricostatus* Dall, *B. crebricostatus undatus* Dall, and *B. kennicotti* Dall. These include shells furnished by the U. S. National Museum, among them the type of *B. c. undatus*, through the courtesy of Dr. Harald Rehder; by the Stanford University Department of Mineral Sciences from Dr. Myra Keen; by the San Diego Society of Natural History from Mr. E. P. Chace; and several specimens from the private collections of Messrs. Walter J. Eyerdam, of Seattle, and John Q. Burch, of Los Angeles.

One obvious problem in studying shells of the genus *Beringius* is the relative scarcity of material. One must, at present at least, draw conclusions on but few specimens, often only a single one from a given locality. Many are beach-worn or damaged, or are not sufficiently full grown to show adult characters well. But even under these difficulties it seems possible to draw some tentative conclusions about certain described forms for the benefit of others who may desire to pursue the problem further upon acquisition of more and better material.

The shells now before me, with others seen and studied, present a puzzling array. Identification of them with described and figured species is difficult and can be only tentative in view of the wide variation in sculptural characters and in the shape aspects of the shells. There appear to be four more or less distinct categories represented by *Beringius* shells with heavy spiral ribbing as follows:

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1. Fairly long-spired shells with strong spiral ribs and relatively little or no evidences of transverse ribbing or plications. Numbers of major spirals range from 8-14 on the body whorl and 3-6 on the earlier postnuclear whorls. *B. crebricostatus*

2. Fairly long-spired shells with more numerous and less strong spiral ribs and prominent transverse ribs or plications. On the body whorl the spirals may be continuous over the entire area, or may be strong only below the periphery and weak or sub-obsolete above it. Numbers of major spirals are 8 or more on the postnuclear whorls. The transverse ribs or plications range in number from 12-15 per whorl. *B. kennicotti*

3. Shells similar to "2," preceding, but transverse ribbing much weaker and sometimes obsolete. *B. undatus*

4. Shells with spiral sculpture similar to "2," preceding, but with shorter spire, more tabulate whorls, extremely deep sutures, and a more tumid body whorl. *B.*, new species

In all specimens seen the canal is short and, if not worn or broken, has a series of weaker, closely spaced ribs on it ranging from 5-9 in number. Although a well-marked fasciole is sometimes present, generally it is weak or absent.

The line of demarcation between *B. crebricostatus* and *B. kennicotti* is fairly distinct; but between *B. kennicotti* and *B. undatus* it is much less so. In fact, with more and better material than is now available, these latter two species possibly can be merged into a single variable species. Based on the shells at hand, *B. crebricostatus undatus* Dall, 1919, seemingly is wrongly placed and should stand, at least for the time being, as a separate species more closely related on sculptural criteria to *B. kennicotti* than to *B. crebricostatus*.

BERINGIUS CREBRICOSTATUS (Dall), 1887.

Pl. 1, fig. 1

This is the type species of the genus and has been well figured. Sculpture consists of heavy, flat-topped, spiral ribs, separated by deeply channeled interspaces. The ribs are "swaged" at the summits so as to overhang the interspaces slightly. While the original description and figure indicate 3 of these revolving ribs occur on the penultimate and earlier postnuclear whorls, a beach-worn and damaged specimen in the Stanford Collection (No. 7213) from Simeonof Island, Alaska, has 6 revolving ribs but is typical otherwise. Another Stanford shell from Unalaska, the type locality, is illustrated on plate 1, fig. 1. It has 4 prominent spiral ribs on the penultimate whorl with a 5th weak one just below the upper

suture; the earlier whorls have 3 ribs, with a weaker one just above the lower suture. In this shell, the channeled interspaces are much wider than the spiral ribs. The approximate number of spiral ribs on the body whorl is given as 14 in the original description but on the two Stanford specimens it is 13 and 14, respectively.

Related to *B. crebricostatus* is a fine adult specimen collected alive off British Columbia in 238 fathoms (U.S.N.M. No. 210299, U.S.F.C. Sta. 2862). This has 6 spiral ribs on the early post-nuclear whorls and about 19 on the body whorl and canal. In this shell, the ribs are much narrower than the channeled interspaces and are less prominent overall than in the typical form.

In *B. crebricostatus*, evidences of broad transverse ribbing across the whorls are slight, and this feature seems not to apply to the species when compared with *B. kennicotti*. Evidently one also must allow for considerable variation in the number of spiral ribs, their relative prominence, and their widths compared with the corresponding widths of the adjacent channeled interspaces. In general, the species has a comparatively long-spired shell, the length of the spire being about equal to or greater than the length of the aperture and canal. Such measurements should, of course, make proper allowance for missing nuclear whorls as these are often lost or damaged.

If the above allowances for sculptural variation are correct, the range of the species is extended from the Aleutians south at least to a position off the British Columbia coast. Thus it overlaps the ranges of other forms to be considered.

"COLUS" PERISCCELIDUS Dall, 1891.

The National Museum type lot consists of two fine specimens, No. 122643, U. S. Fish Commission Station 2842 off Akutan Islands, Aleutians. As has long been suspected these shells, which are now before me, have the characters of a diminutive *Beringius* belonging to the group of *B. crebricostatus*. Placement in the genus *Colus* is questionable. The two specimens in the type lot are almost identical in measurements but only one has a perfect lip. McConnell's drawing in the Proc. U. S. Nat. Mus. 17, 1894, pl. 27, fig. 6, is an excellent representation. Another somewhat smaller specimen in the collection of the U. S. Geological Survey

(No. D 397) from Lash Bay, Tanaga Island, Andreanof Group, Aleutians, has the tops of the spiral cords "swaged" so as to overhang the adjoining channels, as in typical shells of *B. crebri-costatus*.

BERINGIUS KENNICOTTI (Dall), Pl. 1, figs. 2 and 3.

Two specimens that conform to the general requirements of this species are in the Stanford University Collection. One (No. 929-1) comes from Petersburg, Alaska; the other (No. 7215, old no. 929-2) from Kodiak Island, Alaska. These are illustrated on pl. 1, figs. 2 and 3. Both have about the same numbers of spiral ribs on the body whorl and canal (23 and 26, respectively); each has 10 spirals on the earlier whorls. The transverse rib count on the last three whorls, starting with the body whorl is 12 - 15 - 15 for the Petersburg shell and 13 - 14 - 13 for the specimen from Kodiak Island. These transverse ribs or plications are strong above the periphery of the body whorl but become gradually weaker below it in both specimens. The major difference between the two specimens lies in the fact that the spiral ribs on the body whorl are strong throughout on the shell from Kodiak Island, whereas on the shell from Petersburg these are extremely weak from the summit of the whorl to a point just below the periphery where they become equal in strength to those on the Kodiak shell. This difference in sculpture is liable to be confusing unless allowance is made for it in relating single specimens to this particular species.

B. kennicotti incisus Dall, 1907, has not been seen by the writer but is believed to be another sculptural variant.

BERINGIUS UNDATUS Dall, 1919. Pl. 1, figs. 4 & 5, pl. 2, figs. 1 & 2.

The type specimen is figured here for the first time on pl. 1, figs. 4 and 5. It is U.S.N.M. No. 223031 and comes from 160 fathoms, mud, off Cygnet Inlet, Boca de Quadra, southeast Alaska (U.S.F.C. Sta. 4224). As stated, it is a relatively young specimen and contains the operculum. The number of transverse plications on the body whorl is 17, which is larger than average, the range in other specimens studied being 12-14.

The transverse plications in some specimens of *B. undatus* are relatively weak and difficult to count with accuracy. Because these do not appear to be a major sculptural feature of the spe-

cies there seems good reason to make a generic distinction between it and *B. kennicotti*. Considering the possible limits of sculptural variation in shells of the genus, however, the relationship between the two nominal species is admittedly close and we may be dealing with a single polymorphic species. Specimens studied, that are considered to belong to *B. undatus*, are as follows:

1. A single specimen dredged to the north of Unimak Island, Aleutians, in 41 fathoms, sand (U.S.N.M. No. 122718, U.S.F.C. Sta. 3259). This is a fairly large, heavy-textured, thick-lipped shell 115 mm. long, taken alive. Spiral ribbing is strong throughout, there being 21 on the body whorl and seven each on the two preceding whorls. Transverse plications are weak, the numbers on the last three whorls being 11-12-13, respectively, starting with the body whorl.

2. The type specimen from Boca de Quadra, southeast Alaska, and another smaller specimen from the same general locality and depth (U.S.N.M. No. 222589, U.S.F.C. Sta. 4225).

3. A single large, full grown specimen, 143 mm. long, from off Masset, British Columbia, in the Stanford Collection (No. 7214). This shell is illustrated on pl. 2, figs. 1 and 2. Numbers of spiral ribs on the last three whorls are 18-9-9, starting with the body whorl. The canal has a series of 9 ribs. The channeled interspaces are not as deeply cut as in most of the other shells of this species that have been studied. Transverse plications are fewer than average and number 12-12-11 on the last 3 whorls. The shell is well preserved but not collected alive.

4. Two specimens in the Stanford Collection (No. 7214) from off the San Juan Islands, Puget Sound, Washington, in 25-30 fathoms. These are labeled "*B. crebricostatus* var. *undatus* Dall (1919)" in Dall's handwriting. One is an imperfect, full grown "dead" shell; the other is a young one with the nuclear tip complete.

5. A single young shell, dredged off Flat Point, Lopez Island, Puget Sound, in the California Academy of Sciences Paleo. Collection (No. 34789), illustrated on pl. 2, fig. 6.

BERINGIUS EYERDAMI, new species Pl. 2, figs. 3, 4; Pl. 3, figs. 1-4.

The specimens from Messrs. Stiles and Eyerdam differ markedly from other species with heavy spiral ribbing and seem worthy of a new name.

Holotype: Shell an adult specimen, large (about $4\frac{1}{2}$ inches long), of fairly heavy texture, globose, creamy-white, covered in places with a thin, golden-brown periostracum. Nuclear whorls missing; postnuclear whorls about $4\frac{1}{2}$, well-rounded, tabulate

at the summits, with fairly deep sutures. Body whorl tumid, constricted at the base to form a short but wide, relatively straight siphonal canal. Axial sculpture faint, consisting of a series of broad, low irregular, widely-spaced, undulating plications, more evident on the upper portions of the postnuclear whorls but fading out almost entirely on the body whorl. Spiral sculpture prominent and strong over all postnuclear whorls, consisting on the first of 6, on the next of 7, and on the body whorl of 15 heavy, square-cut, revolving ribs bounded by narrower but deep, square-cut channels that are concave at their bottoms; both spiral ribs and their interspaces widen gradually as they approach the outer lip of the aperture, which is crenulated inside to correspond with the heavy outside spiral sculpture. Outside of canal worn, devoid of ribbing in the holotype. Over-all microsculpture consisting of close, irregularly placed, growth riblets that continue over the spiral ribs and into the channeled interspaces. Major spiral ribs on the body whorl generally cut by one, centrally placed, weak, incised line and sometimes by more still weaker ones. Aperture capacious, subovate, of a pinkish color inside; outer lip thick, not flaring; inner lip appressed, consisting of a heavy wash of callus; columella slightly curved. Canal wide, short and relatively straight. Just inside the mouth of the shell on the upper side of the inner lip is a broad, low, rounded, raised area or boss. Operculum thick and coarse, normal for the genus. Animal (in alcohol) a female, the upper portion of the mantle yellowish-white, lightly dusted with irregular, light gray maculations; edge of mantle incised and ribbed corresponding with the outside sculpture of the shell, the ribs marked with red-brown for a distance of about 5 mm. back of the edge. Dimensions of shell in mm.: length, 113.9; maximum diameter, 74.8; maximum width of aperture, 37.7; length of aperture and canal, 75.0; length of canal alone, approximately 23.5 mm.; number of postnuclear whorls, $4\frac{1}{2}$.

Locality and disposition of specimens: Dredged at various times in 1957 and 1958 by the trawlers "Cooledge II," "Karen," "Northern Light," and "Paul L." in approximately 100 fathoms on La Perouse Bank about 40 miles off Cape Flattery opposite the entrance to the Strait of San Juan de Fuca, Washington. Holotype in the Calif. Acad. Sci. Paleo. Type Coll. (C.A.S. no. 36318). A total of 14 paratypes from the same general locality have been designated as follows: 2 in Calif. Acad. Sci. Paleo. Type Coll.; 8 in the collection of Mr. E. C. Stiles; one in the collection of Mr. Walter J. Eyerdam; 3 in the collection of Mr. John Q. Burch; and one in the collection of the San Diego Society of Natural History.

Geographical Range: Chignik, Alaska (Norberg) to the coast of Washington in about 100 fms. off the Strait of San Juan de

Fuca (Stiles); Puget Sound, Washington (Eyerdam).

Remarks: Because so many specimens of a large, deepwater *Beringius* are available for study at one time, somewhat detailed comments on the range in variation of the shells seems pertinent. The total number at hand or otherwise known is as follows:

The holotype and 14 paratypes, from the type locality, obtained by Mr. Stiles. The paratypes include 3 kindly loaned by Mr. and Mrs. Burch and one supplied by Mr. Eyerdam, who also furnished the holotype. An additional specimen (topotype) is stated to be in the collection of Mrs. Elizabeth Phelps, Delray Beach, Florida, has not been available for study.

A single shell (paratype) in the museum of the San Diego Society of Natural History (No. 12917) from off Vancouver Island, British Columbia.

Two shells obtained by Mr. Ingvar Norberg at Chignik, Alaska, one of which is in Mr. Eyerdam's collection and the other said to be in the Tromsø Museum, Norway. The latter of these has not been studied.

A single shell collected by Mr. Eyerdam during seine operations for herring in 1945 at Raspberry Island, Kodiak Island Group, Alaska.

A single full-grown but "dead," worn specimen collected by Mr. Eyerdam in Puget Sound at Restoration Point, Bainbridge Island, Kitsap Co., Wash.

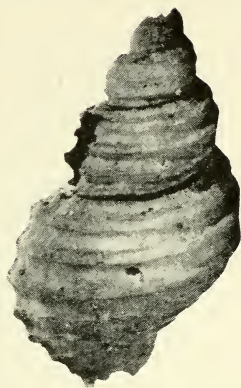
Comments on these follow in the order listed.

Of the 15 shells from La Perouse Bank obtained by Mr. Stiles, which are at hand, 9 are fine specimens taken alive and have opercula. Two, including the holotype, have the animals preserved in alcohol; both are females. The remaining 6 are "dead" shells, somewhat worn; one of these is a poorly preserved, half-grown specimen. Thirteen of these shells have the heavy spiral sculpture described for the holotype and are remarkably constant in this outstanding feature, although there are minor variations. Several have all, or nearly all of the smooth nuclear whorls present, which may number from 2 to $2\frac{1}{2}$; they are all somewhat worn, however. Where these are broken off the animal plugs the open hole with shell material, a condition present in the holotype. In several of the better preserved shells, the spiral ribbing continues over the outside of the canal but in diminishing strength, the canal being sculptured with a series of about 9 of these weaker ribs, which are closely spaced and bordered by wider, shallow interspaces. The incised spiral lines on top of the major ribs vary considerably and are absent on some shells.

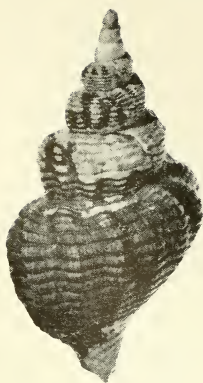
Although a flaring lip seems not to be a feature of the species, in two specimens there is a marked recurving toward the outer edge and in one of these the lip is much thickened and doubled. Color also varies somewhat. The thin periostracum when present, is light brown in some specimens, without the golden hue. One unusually fine fresh shell is a beautiful pinkish-brown color over all. In such fresh shells the color inside the aperture ranges from pink toward a light purple, which evidently changes to lighter flesh or salmon pink with age or exposure to light.

The other two shells in the type lot deviate remarkably from the normal heavily ribbed form. On the the most striking one of these, a "dead" shell illustrated on pl. 3, fig. 2, there is no spiral ribbing whatever on the upper whorls; toward the base of the body whorl, however, a series of four strong ribs bordered by quite narrow channels appears abruptly; the usual series of weaker ribs occurs on the outer canal. Axial sculpture consists of broad, very irregular undulations of varying prominence. Over-all microsculpture appears as the usual closely set growth riblets but these are finely beaded in an axial rather than in a spiral direction. The shell is shorter than normal, with a stubby spire, the summits of the tabulate whorls descending into the sutures, a feature not exhibited in the normal heavily ribbed specimens.

While there is a possibility that this single specimen may be a pathologic variant, the other of the two with aberrant sculpture and other aspects seems perfectly normal. It was collected alive and has the longer spire of the heavily ribbed form from the area; it is illustrated on pl. 3, fig. 3. The heavy spiral ribs are only 7 in number and begin abruptly well below the periphery of the body whorl, with the usual series of weaker ribs on the outer canal. The upper part of the body whorl is sculptured with 6 or 7 weak spiral cords, widely spaced, and bordered by wide, shallow interspaces. At the summit of this whorl is a maze of similarly weak cording, which originates at the suture and extends diagonally to the area where the spiral cords begin. (This feature is suggested also in the figure of *B. marshalli* Dall, 1919, in Bull. 112, U. S. National Museum, p. 91, pl. 9, fig. 3.) The summits of the whorls also show a descending tendency into the sutures. Microsculpture of this shell has been lost due to unfortunate treatment with acid in cleaning it.



1



2



4



3



5

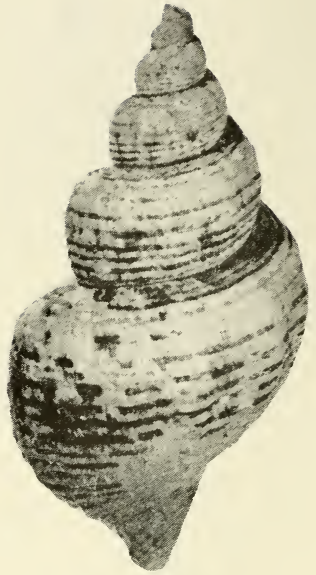


6

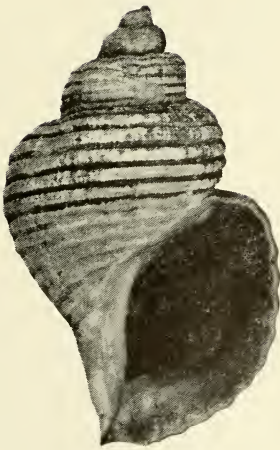
1, *Beringius crebricostatus* (Dall) . 2, 3, *B. kennicotti* (Dall) . 4-6, *B. undatus* Dall.



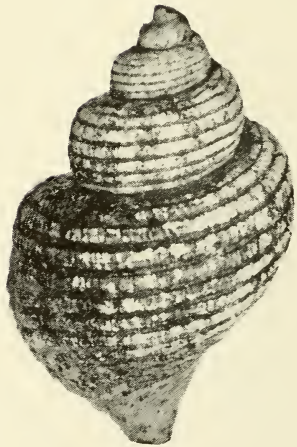
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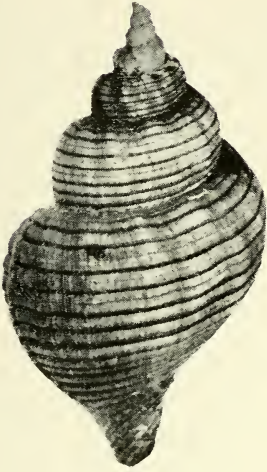


3



4

1, 2, *Beringius undatus* Dall. 3, 4, *B. eyerdami* A. G. Smith, type.



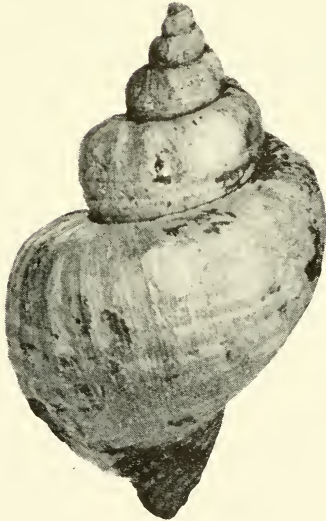
1



2



3



4

1-4, *Beringius eyerdami* A. G. Smith.



Decipifus gracilis McLean 1. (left) Holotype, Stanford Univ. Paleo. Type Coll., no. 8081, x 5. 2. Paratype, Stanford Univ. Paleo. Type Coll., no. 8082, x 5. Off Guaymas, west Mexico.

LIST OF FIGURES

Plate 1.

1. *Beringius crebricostatus* (Dall), Simeonof Id., Alaska. Stanford Univ. Coll. No. 7213. Length, 102 mm.
2. *B. kennicotti* (Dall), Petersburg, Alaska. Stanford Univ. Coll. No. 939-1. Length, 99.1 mm.
3. *B. kennicotti* (Dall), Kukak Bay, Kodiak, Id., Alaska. Stanford Univ. Coll. No. 7215 (old No. 929-2). Length, 94.6 mm.
- 4, 5. *B. undatus* Dall. Type, from 160 fms., mud bottom, off Cygnet Inlet, Boca de Quadra, Alaska (U.S.F.C. Sta. 4224). U. S. National Museum Coll. No. 223031. Length, 79 mm.
6. *B. undatus* Dall, dredged off Flat Pt., Lopez Id., Puget Sound, Wash. Calif. Acad. Sci. Coll. No. 34789. Length, 92.3 mm.

Plate 2.

- 1, 2. *Beringius undatus* Dall, dredged off Masset, Br. Columbia. Stanford Univ. Coll. No. 7214. Length, 142.8 mm.
- 3, 4. *B. eyerdami*, A. G. Smith, new species. Holotype, from approx. 100 fms., La Perouse Bank, 40 mi. off Cape Flattery, Wash. Calif. Acad. Sci. Paleo Type Coll. (C.A.S. No. 36318). Length, 113.9 mm.

Plate 3.

1. *Beringius eyerdami* A. G. Smith, new species. Paratype in W. J. Eyerdam Coll. Length, 120.6 mm.
2. Same. Paratype in Calif. Acad. Sci. Coll. No. 36318. Aberrant specimen with obsolete spiral sculpture. Length, 99.9 mm.
3. Same. Paratype in Calif. Acad. Sci. Coll. No. 36318. Aberrant specimen with spiral sculpture stronger. Length, 117.2 mm.
4. Same. Raspberry Id., Alaska (Eyerdam). Calif. Acad. Sci. Coll. No. 36319. Length, 132.8 mm.

Note: Front views taken with axis of shell horizontal. Back views with shells resting on their apertures, with axes slightly tipped upward so as to show sutural characters more clearly.

(To be continued)

A NEW MARINE GASTROPOD FROM WEST MEXICO

By JAMES H. McLEAN
Stanford University

A new gastropod, which fits into the genus *Decipifus*, recently proposed by Olsson and McGinty, was collected by the author in December, 1958, at Guaymas, Mexico. *Decipifus* belongs to the family Columbellidae.

DECIPIFUS Olsson and McGinty, 1958.

Bulls. of Amer. Paleont., vol. 39, no. 177, p. 36. Type species (monotypy), *Decipifus sixaolus* Olsson and McGinty, 1958. East Panama.

Original description: "Shell quite small, *Phos*-like in shape and sculpture. Protoconch is relatively large, subcylindrical, formed of 1 to $1\frac{1}{2}$ smooth whorls, the final section high and the apical tip inrolled. Sculpture of the mature whorls is formed by low, narrow riblets finely beaded by spirals. Aperture semi-elliptical with a small, indistinct canal at the suture; lip simple; columella straight, the tip of the pillar slightly twisted; no external fasciole."

DECIPIFUS GRACILIS, new species.

Plate 4

Shell small, fusiform, aperture subovate, $\frac{3}{8}$ of length. Sculpture consisting of 7 low, flat-surfaced spiral cords between sutures, 13 to 15 cords on base, crossed by 13 to 16 somewhat sinuous axial ribs, (13 on early whorls), the axial ribs becoming obsolete on base; entire surface with minute axial striae. Siphonal notch deep, columella smooth, outer lip simple but reflecting spiral cords. Ground color buff, with variegated dark brown and blue-green mottling, brown on the 4 upper cords of each whorl and on the pillar, many of the bead surfaces white.

Dimensions: Holotype, length 8.2 mm., diameter, 3.7 mm. Paratype, length 8.0 mm., diameter, 3.5 mm.

Type locality: Bocoibampo Bay, Guaymas, Sonora, Mexico, about 50 feet offshore from the north end of the bay, in six feet of water, under rocks. Holotype and paratype collected by the author, December, 1958.

Repositories: Holotype, Stanford University Paleontological Type Collection, No. 8081; paratype, No. 8082.

This species appears to be distinct from *Amphissa lyrta* Baker, Hanna and Strong (1938) which probably belongs to this genus also, in that *Decipifus gracilis* is more slender, has deeper sutures, 7 cords rather than 6 between sutures, 13 to 15 cords on the base rather than 10, and shows the blue-green mottling. *Decipifus lyrta* (Baker, Hanna and Strong) is known from Isla Partida and other islands near southern Baja California. The two west American species of *Decipifus* appear to differ significantly from the four species of *Amphissa* examined in the Stanford collection. Although the overall shape and sculpture is similar, the beading of *Decipifus* is more pronounced, there is less inner lip callus, and the two species are much smaller than the minimum size of *Amphissa* (9 mm. compared to 13 mm.). The southernmost range

of *Amphissa* is Cedros Island, (*A. versicolor* Dall), according to Grant and Gale, 1931. Thus *Decipifus* and *Amphissa* are also geographically distinct.

The types of *D. gracilis* examined may be immature specimens, for the outer lips are thin and sharp. This may also account for the absence of the slight posterior canal characteristic of *D. sixaolus*. Although the specimens were taken alive, the operculum was not saved. Conceivably populations of *D. gracilis* may be of more general occurrence than is suspected, since collecting has not been as extensive in the subtidal as in the intertidal and dredged areas. Diving in the same spot also yielded specimens of *Engina tabogaensis* Bartsch, 1931, and *Anachis gilva* (Menke, 1847), both unknown north of Mazatlan until recent months.

Acknowledgments: I wish to express my thanks to Dr. A. Myra Keen, of Stanford University, for her help in the preparation of this paper and to Mr. Robert Robertson, of Harvard University, who first noticed the similarity of "*Amphissa*" *lyrta* to the type species of *Decipifus*. He also has confirmed the placement of *Decipifus* in the Columbellidae from a study of the radula of an east coast species. (Letter to A. M. Keen dated December 30, 1958.)

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NOTES ON THE FEEDING OF MELONGENA CORONA

By RUTH D. TURNER

Museum of Comparative Zoology

At the time that W. J. Clench and I were working on the Melongenidae for Johnsonia, David and Nevada Schmidt sent us 6 live specimens of *Melongena corona* (Gmelin) from Punta Rassa, Florida. They arrived in early March, 1952, and were

immediately placed in a salt water aquarium in the laboratory where 5 of them are still doing very well (January, 1959). An account of the care of these mollusks was published in *Turtos News* (Turner, 1956) and notes on egg laying and development in *Johnsonia* (1956, p. 162). Continued observations on the feeding of these animals have shown that there must be some means of communication among them. They invariably feed together, "ganging up" on one clam even though there are plenty of others to feed upon. Though these snails are usually rather quiet and crawl only on the bottom of the aquarium, just before feeding one specimen becomes very active and crawls up on the blocks of peat or the sides of the aquarium with its siphon fully extended and actively waving from side to side. Finding a clam, usually a small *Mercenaria mercenaria* (Linné) purchased at the local grocery store, this first specimen will envelop it with its foot and within a half-hour all the others will be on the victim aiding the one that began the process. Just how the proboscis is introduced between the valves, we have not been able to observe. However, when feeding is well along, one can pick up the snails and also, hanging from their extended proboscises, the tightly closed clam. When feeding is finished, the clam shells are gaping and completely cleaned out. *Melongena corona*, unlike *Thais lapillus* (Linné), which we have also had in our tanks, never kill more clams than they can eat and consequently never foul the tank with rotting, uneaten clam meats. Specimens of *Thais lapillus* do not feed together but each one attacks a different clam. They were unable to eat *Mercenaria* but fed readily on *Mytilus*. Clench (1947, p. 66) recorded a similar "ganging up" of specimens of *Purpura patula* (Linné) when feeding on chitons.

Recently a number of badly broken specimens of *Mercenaria mercenaria* were placed in the aquarium and though the meats of these clams were readily available and each *Melongena* could have had a "private dining table" they still all fed on a single specimen. A clam was placed very close to one specimen of *Melongena* which immediately became active and within 15 minutes all the other *Melongena* were headed toward this specimen, ignoring broken clams which were much closer to them. Consequently it does not seem possible that the "signal for feeding" could have come from the "odor" of clam meat in the water but rather from the first *Melongena* which had begun to feed. That

this is not true of all members of this family is evidenced by observations made in the field on *Melongena corona johnstonei* Clench and Turner. In Little Lagoon, Alabama, we observed individuals of this subspecies feeding singly on *Tagelus divisus* (Spengler). In the clear water of the lagoon, the *Melongena* could be detected at some distance and, if they were not moving about, we usually found, on picking one up, that the proboscis was extended down into the burrow of a *Tagelus*. The soft parts were complete cleaned out, leaving the shells in place. These clams with their gaping valves, however, have no protection against the *Melongena* and a cooperative attack is unnecessary.

Comfort (1957) reviewed all the known data on the life span of mollusks, listing 133 species for which some data were available; of these 35 were prosobranchs. This is an appallingly small number, and consequently we deem worthy of record the fact that we have had *Melongena corona* living in our aquarium for nearly 7 years. The specimens were at least a year old, and considering their size probably 2 or 3 years old at the time we received them. None of the specimens has grown more than a quarter of a whorl since we have had them. One died in August, 1958, but whether this was from old age or some other cause we were unable to determine.

Although our specimens have produced egg capsules quite regularly and the young snails have emerged and crawled to the water line, conditions in our tank were not satisfactory for their survival. At least 3 females have been observed depositing egg capsules and they invariably do this at the end of the aquarium away from the window and in a common area. There is still much to be learned and it is hoped that this note will encourage others who are favorably situated to record similar observations on these and other mollusks.

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SNAILS FROM UPPER PENINSULA OF ALASKA WITH FEEDING HABITS OF BROOKS LAKE FISHES*

BY BRANLEY A. BRANSON AND WILLIAM R. HEARD

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During the summer of 1958 (May-September) the junior author, working as a fishery aide at the U. S. Fish and Wildlife Service Research Station at Brooks Lake, collected a few land snails and some rather important data on the malacophagous habits of several species of fishes. Brooks Lake is situated in the Katmac National Monument on the Upper Alaskan Peninsula. The lake is a relatively deep one (maximum 252 feet) but gastropod habitats are mostly restricted to the shallow north end and to the peripheral ring of its basin lying less than 10 to 25 feet below the surface. This is the region of effective plant growth, consisting mostly of a species in the algal genus *Chara*.

Several specimens of *Succinea strigata* Pfeiffer were collected in a peat bog near banks of the Naknek River in the region of King Salmon, July 21, 1958. This form is apparently rather ubiquitously distributed in Alaska (Hanna, 1956 and others).

Deroceras laeve (Müller) is a small grayish or blackish slug with a soot-colored foot. Our specimens are typical of the one called *Agriolimax* (= *Limax*) *hyperboreus* (Westerlund) by Dall (1903), but proved to be conspecific with *D. laeve* by Waldén (1956). These specimens were "captured" near Brooks Lake, July 13, 1958, and days following, on the trips of dead-fall, small-mammal traps baited with peanut butter. (We have since used peanut butter in bottle tops to attract Oklahoma slugs with a great deal of success. In addition, several *Polygyra texasiana* [Moricand] were collected in this manner, as well as numerous insects.)

The periphyton referred to above in the brief characterization of Brooks Lake fosters a population of *Lymnaea emarginata* Say that is incredibly large in numbers. Associated with this species, and only slightly less abundant, are *Menetus cooperi planospirus* F. C. Baker and *Valvata helicoidea* Dall. This massive population was observed and a few specimens of each species collected (Aug. 6 and 19, 1958) by using SCUBA. gear. The following

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notes will show that these gastropods obviously are very important in the economy of Brooks Lake piscine inhabitants.

During the course of the summer's work experimental gill nets were utilized to capture 75 to 80 Dolly Varden charrs, *Salvelinus malma* (Walbaum), one lake trout, *S. namaycush* (Walbaum), several round whitefish, *Prosopium cylindraceum* (Pallas), several blackfish, *Dallia pectoralis* Bean and thousands of the ninespine stickleback, *Pungitius pungitius* (Linnaeus). Observations were made on the stomach contents of all the charrs, but only on samples of the other species of fishes. These data will be analyzed in considerable detail elsewhere and conclusions drawn therefrom. Here, we wish, for the purpose of records, to report the species involved as food for the fishes mentioned above.

Menetus cooperi planospirus was found in the stomachs of the round whitefish and blackfish in relatively large numbers and in the Dolly Varden charr less frequently. In large adults of the last species, this small snail is probably taken secondarily while the fish is feeding on the following, larger gastropod species.

Many specimens of *Lymnaea emarginata*, strongly resembling the form reported as *randolphi* by Dall, were taken from the Dolly Varden. One medium-sized fish had 82 snails in its stomach and an 8 lb. charr was found to contain 253 gastropods, some of them measuring up to 25 mm. in length. Little else was found in the fish's stomach. *Prosopium*, a known mollusk-eater, was also found to take many individuals of this species. *Dallia* apparently takes only an occasional *L. emarginata*, which, because of the small size of the fish, is usually tiny.

The round whitefish and *Pungitius* were the only fish species observed to have been feeding upon *Valvata helicoidea*. The whitefish devours many *Valvata*, the stickleback relatively few.

The lake trout is not notorious as a mollusk-eating fish. However, one specimen of *L. emarginata* and one empty shell (both valves) of *Pisidium idahoense* Roper were found in a large fish. Since this species eats whitefish in some numbers, it may have ingested the mollusks along with the fish prey.

These data may turn out to be rather important in helping to explain why there is little predation upon the valuable sockeye salmon at Brooks Lake by the Dolly Varden charr. Possibly the

charr, in the face of such an abundant supply of readily available food in the form of gastropods, may take fish species only when such a menu is lacking in the habitat. This, of course, is an assumption that will have to be verified.

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A METHOD FOR FULL RELAXATION OF MURICIDS¹

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Abstract. A method is recommended for full relaxation and killing in an expanded condition of *Urosalpinx cinerea*, *Eupleura caudata etterae*, *Thais haemastoma floridana*, *Ocenebra erinacea*, *Nucella lapillus* and *Polinices duplicatus*. Gastropods are made partially insensible in a solution of 10 ppm. of 1-naphthyl N-methylcarbamate ("Sevin") in one atmosphere of CO₂ and then frozen quickly on dry ice.

Current study of the comparative functional morphology of boring mechanisms in muricid gastropods by the senior author (Carriker, 1958a, 1958b) disclosed lack of a method for thorough relaxation of these marine snails. Of the many chemicals employed in narcotization of gastropods, cocaine is reported (Lo Bianco 1899) to provide maximal relaxation, but in the muricid *Urosalpinx cinerea* it effects only partial expansion of the soft parts (Carriker 1943).

In this investigation, we tested a number of narcotics in search of a method to produce fully expanded prosobranchs (mainly Muricidae) for detailed anatomical dissection and experimental surgery with subsequent recovery of the animal. Active, adult *Urosalpinx cinerea* (Say) (collected in Beaufort Inlet, North

¹The bulk of this research was performed at the Institute of Fisheries Research, and was supported by a U. S. Fish & Wildlife Service grant, Federal Contract No. 14-19-008-2376.

Carolina) and *Eupleura caudata etterae* B. B. Baker (the large ecologic form of *Eupleura*, kindly provided by T. Carver, M. Castagna, and G. Griffith, U. S. Fish & Wildlife Service, from Chincoteague Bay, Virginia) were the principal experimental animals employed. In addition small numbers of local *Thais haemastoma floridana* Conrad (from Cape Lookout, N. C.; identification kindly verified by Ruth D. Turner) and the naticid *Polinices duplicatus* Say (from Beaufort Inlet, N. C.), and British muricids *Nucella* (=Thais) *lapillus* (Linné), *Urosalpinx cinerea* (Say), and *Ocenebra erinacea* (Linné), were tested. The British gastropods were obtained by the senior author through the generous cooperation of F. S. Russell, P. R. Walne, and G. D. Waugh during the summer of 1958 while on a trip to the British Isles. All experimental snails were maintained in laboratory running sea-water except the British snails which, not tolerating the high temperature of the laboratory running sea water, had to be housed in refrigerated containers under aeration. Thus there was no possibility of introducing the British snails in native American waters.

Sets of five or more snails per container were subjected to (a) increasing concentrations of narcotic, each concentration in a separate container, (b) gradual addition of narcotic to one container, and (c) combinations of concentrations of narcotics in (a) showing promise as relaxing agents. Extent of expansion of pedal and cephalic regions out of the shell, sensitivity of tentacles to touch, and reaction of the snail to dilute formalin were utilized as indices of depth of narcosis and degree of relaxation. Mechanical shocks were avoided which might cause snails to retract before full narcosis was achieved. Solutions of narcotics were prepared in sand-filtered sea water ranging in salinity from 20 to 37 o/oo, and temperature of the water in experimental dishes ranged from 22 to 28° C during the course of experimentation.

Tricaine methanesulfonate (M.S. 222), metycaine hydrochloride, dibucaine hydrochloride, and a combination of phenobarbital and belladonna, caused snails to retract tightly. So did Gohar's (1938) formalin treatment recommended for killing the refractory opisthobranch *Aeolis* in an expanded condition. Slow cooling (Gohar 1938) brought about slow withdrawal, a response

related to behavior in temperate regions where *Urosalpinx* migrates bottomward and remains closely affixed to hard surfaces as temperatures drop in the fall (Carriker 1955).

Cocaine hydrochloride, phenoxetol ($C_6H_5OCH_2CH_2OH$, similar to propylene phenoxetol used by Owen, 1955), chloretone and menthol (added as crystals), ethyl carbamate (urethane), chloral hydrate, and $MgSO_4$ effected partial to full extension and slight to moderate insensibility. However, even the most effective of these narcotics produced variable unpredictable degrees of relaxation, and percentage of well relaxed insensitive mollusks was relatively small. All narcotized specimens retracted fully when cut or immersed in dilute formalin. Combination of the more effective narcotics in their most effective concentrations (e.g., phenoxetol 0.1%, ethyl carbamate 0.5%, and cocaine 0.05%) did not compound desirable effects of separate narcotics. Neither aeration of the narcotizing solution (as attempted with cocaine and phenoxetol), nor addition of narcotic slowly (phenoxetol, formalin, $MgSO_4$, cocaine, and a mixture of $MgSO_4$ and cocaine), nor use of snails carefully removed from the shell enhanced narcosis.

Full expansion of muricids was obtained by immersion in (a) sea water under one atmosphere of CO_2 , (b) 10 ppm. (parts per million) of tetraethyl monothionopyrophosphate in sea water, and (c) 10 ppm. of 1-naphthyl N-methylcarbamate ("Sevin") in sea water.²

Passage of CO_2 (evolved from dry ice) through an air-tight chamber with an outlet causes snails immersed in sea water in the chamber to extend fully in about seven hours. However, snails relaxed by this method remain slightly sensitive to touch and retract vigorously when placed in dilute formalin.

Tetraethyl monothionopyrophosphate³, a liquid soluble in sea

²Loosanoff and associates are developing methods for chemical control of shellfish enemies (Bull. No. 12, 1956, U. S. Fish & Wildlife Service, Mar. Biol. Lab., Milford, Conn.) and discovered that Sevin and the pyrophosphate relax certain gastropods, and that Sevin shows promise in controlling gastropod and other enemies of oysters. Loosanoff kindly recommended the use of these two chemicals, provided the Sevin, and suggested a concentration for relaxing muricids which our study confirmed.

³This chemical, CP 847, was kindly contributed by the Development Department, Monsanto Chemical Company, St. Louis, Missouri. It is no longer manufactured.

water (and extremely toxic to mammals) relaxes muricids fully in an hour, and they remain extended in it for at least 24 hours. However considerable sensitivity is retained by snails during the first 4 hours; this decreases toward the 10th hour when snails are less sensitive than when in CO_2 . Use of pyrophosphate in sea water of salinity of 20 o/oo produces slightly fuller extension of snails than in a higher salinity, probably as a result of osmotic effects. Immersion of narcotized snails in dilute formalin provokes full retraction.

Freshly prepared solutions of 1-naphthyl N-methylcarbamate ("Sevin")⁴ (relatively safe for humans) produce partial relaxation of muricids in an hour, and full extension in four hours. Sevin is less than 0.1 percent soluble in water; solutions were prepared by adding 0.1 g of crystals to 15 ml of acetone and mixing this stock solution in sea water. Narcotization with Sevin is more complete than with either CO_2 or the pyrophosphate. Immersion of snails relaxed in Sevin in dilute formalin stimulates slow but complete retraction. Combination of the CO_2 -Sevin treatments produces more fully extended snails than either treatment alone. Solutions of Sevin prepared in sea water of 28 o/oo salinity produce better relaxation than in 35 o/oo. Denuded snails do not expand as fully as intact snails in the shell.

Freezing, either slowly or rapidly, causes normal muricids to retract deeply, whereas rapid freezing of snails relaxed in CO_2 , pyrophosphate, or Sevin (on dry ice; temperature on this drops at least to -56°C) for 24 hours or more kills the snails in a fully expanded state, and they do not retract into the shell when dropped into preservative or when they are dissected after thawing. After shorter periods of freezing many snails remain irritable and do retract when strongly stimulated.

The results of these experiments led to development of the following method for killing fully relaxed snails:

1. Narcotize snails in a freshly prepared solution of 10 ppm. of Sevin (1-naphthyl N-methylcarbamate) in filtered sea water (25 to 30 o/oo), in a depth of fluid at least thrice the height of the snails, at room temperature, for 1 hour; keep snails out of reach of each other and on their backs with their feet extended

⁴This product is sold under the registered trademark "Sevin" and is available from Union Carbide Corporation, New York City.

freely in the water;

2. Transfer snails to fresh Sevin solution in one atmosphere of CO_2 at room temperature and leave there for three hours;

3. Remove snails from the narcotic one at a time and place the ventral or lateral surface of the foot of each quickly against the surface of a block of dry ice held in a deep freezer or in an insulated box; then cover the freezing gastropods with chipped dry ice, insulate the preparation, and leave for 24 hours.

Freshly thawed snails prepared in this way are ideal for detailed anatomical study since organs retain color, texture, and pliability characteristic of living relaxed tissues, and take aqueous stains readily. Relaxed snails may be retained in a frozen state indefinitely, provided they are not allowed to desiccate, or may be preserved in a solution of 35 percent ethyl alcohol, 0.5 percent formalin, and 5 percent glycerine in distilled water, which hardens the tissues slightly. The following gastropods have been relaxed and killed successfully in an expanded condition by the Sevin- CO_2 -quick-freeze technic: American Muricidae: *Urosalpinx cinerea*, *Eupleura caudata etterae*, *Thais haemastoma floridana*; British Muricidae: *Urosalpinx cinerea*, *Ocenebra erinacea*, *Nuccella lapillus*. American Naticidae: *Polinices duplicatus*.

Living specimens of these species recover from treatment with either CO_2 or Sevin, and although insensibility is not complete, it is sufficient to permit rapid experimental surgery on superficial portions of the body.

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LAND SNAILS FROM MARYLAND AND VIRGINIA

By WAYNE GRIMM

During the years 1957-1958, additional localities for 5 species of land snails were found in Maryland and Virginia. The collecting stations of these snails are recorded below.

Mesodon appressus (Say). On July 1, 1957, twelve specimens of this species were found under debris in a lumberyard at Cambridge, Dorchester Co., Maryland. This is the second record for *M. appressus* on the Delmarva, the first being a dead specimen from the Chester River across from Chestertown, Queen Anne Co., Maryland (Vanatta). Doubtless the presence of this southern Appalachian species in Maryland is due to accidental introduction, probably from somewhere in Virginia.

Retinella raderi (Dall). A single living specimen was collected on July 27, 1958, at the foot of Dan's Mountain, south of Rawlings, Allegany Co., Maryland, on Highway 220. It was found in wet soil under a rock at the base of a large limestone outcropping. All other snails associated with it were in the leaf litter between loose rocks or at the base of the outcropping. Although the area was searched diligently, no additional specimens of this rare snail were uncovered. Several bags of leaf mould were collected, but *R. raderi* was not among the many snails found therein.

Other snails taken at this unusually fine locality were: *Stenotrema fraternum*, *Mesodon thyroidus*, *Triodopsis albolabris*, *T. tridentata*, *T. fraudulenta*, *Haplotrema concavum*, *Ventridens ligera*, *V. virginicus*, *Zonitoides arboreus*, *Mesomphix cupreus*, *Retinella indentata*, *R. burringtoni*, *Hawaiiia minuscula*, *Guppya sterkii*, *Helicodiscus parallelus*, *Angispira alternata*, *Punctum vitreum*, *Gastrocopta pentodon*, *G. contracta*, *G. armifera*, *Pupoides albilabris*, *Vallonia perspectiva*, *Cionella morseana*, and *Carychium exile*.

Previously, typical *R. raderi* was found only in "subfossil" state at Cumberland, Maryland (Howard Shriver, type 107758

U.S.N.M., topotypes A.N.S.P. 73888).

Limax marginatus Müll. Records for this introduced slug are scattered sporadically on the Coastal Plain.

Maryland: Saltmarsh at Galesville, Anne Arundel Co.; Lumberyard at Cambridge, Dorchester Co.; Saltmarsh near Kent Narrows at Grasonville, Queen Anne Co. Virginia: South portion of Chincoteague Island, Accomack Co.

Previously it was reported from Newfoundland, California, Colorado, and Missouri.

Gastrocopta cristata (Pilsbry and Vanatta). Numerous specimens of this southwestern species were taken from three open, comparatively unsheltered areas on the flat Delmarva Peninsula. At one place it was with *G. procera* (Gould). In the field it was easily separated from *procera* by its larger size, lighter color, and more cylindrical shape. One look into the aperture was sufficient to erase any doubts concerning its identity. This snail may have been introduced on hay from the southwest. Two lots were deposited in the United States National Museum.

Maryland: Under stones in dry weedy area behind Sinclair Station on Route 50 near Skipton, Talbot Co. Under boards in lumberyard at Cambridge, Dorchester Co. With *G. procera* in a dry area near Chicamacomico River at Drawbridge, Dorchester Co.

Vallonia perspectiva Sterki. This diminutive snail was found three times in the Appalachian region of Maryland and Virginia — once in the Blue Ridge, once in the Great Valley, and once in the Ridge - and - Valley province. Records for it are surprisingly few in the East.

Maryland: Under dry limestone, Conococheague Creek and Route 40, Washington Co. Rawlings, Allegany Co. (see above, *R. raderi*). Virginia: Hill near Gooney's Creek Overlook between mileposts 6 and 7, Shenandoah National Park, Warren Co.

I wish to thank Dr. Joseph P. E. Morrison of the United States National Museum for his help in identifying *Gastrocopta cristata*.

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THYSANOTEUTHIS RHOMBUS, LARGE CEPHALOPOD NEW TO THE WESTERN ATLANTIC¹

BY GILBERT L. VOSS AND DONALD S. ERDMAN

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On November 5, 1958, at 1205 noon, Mr. Fred Gurke, angling from the charterboat *Sea Queen III* operated by Capt. Victor Rivera, landed a blue marlin about two miles north of the Carib-Hilton Hotel, San Juan, Puerto Rico. On return to the dock, the fish was weighed in at 383 1/3 pounds, and then, at the request of one of us (Erdman) the fish's stomach was opened in order to examine its contents. Much to the surprise of all concerned, the stomach was found to contain a large squid about 3½ feet long and weighing about 23 pounds. It was lodged in the stomach tail first and except for the loss of the skin from the strong action of the digestive juices of the marlin, was nearly intact, only the ends of the tentacles missing. After a preliminary examination, photographs were taken and the squid was turned over to Erdman for preservation.

The squid was later brought by Erdman to The Marine Laboratory where a more detailed study was undertaken. After a careful examination, it was found to be a large specimen of the squid, *Thysanoteuthis rhombus* Troschel, 1857. This squid has not, heretofore, been recorded from the Western Atlantic. Its measurements are given in the following table.

Table 1. Measurements (in mm.) of Puerto Rican specimen:

Length (less tentacles)	983	Arm length, I	140
Mantle length	670	II	164
Mantle width	190	III	193
Head length	120	IV	165
Head width	80		
Fin length	570	Diameter of largest	
Fin width	440	arm sucker	6

This is a large species of squid, although not attaining the enormous size of the giant squid, *Architeuthis*, or the Humboldt "current" squid, *Ommastrephes gigas*. The largest specimen of

¹Contribution No. 222 from The Marine Laboratory, University of Miami.

Thysanoteuthis recorded had a dorsal mantle length of 800.0 mm or about 30 inches.

The species is unusual among the squids for the very large rhomboidal fins nearly as long as the mantle and the peculiar shape of the cartilages which unite the mantle with the sides of the funnel. The pen also is unique among the cephalopods in that the sides of the vane become free lobed on either side of the rhachis anteriorly.

According to the records available to us, this is the 22nd specimen recorded in the literature and the 2nd adult from the North Atlantic. According to Pfeffer (1912) 11 specimens were then known of which all but 3 very small juveniles or larvae were from the Mediterranean. They ranged from 4.2 mm. to 740.0 mm. in mantle length. Pfeffer in 1910 named another species of the genus, *T. nuchalis*, based on a single specimen of 800.0 mm. mantle length captured off Ningpo in the Yellow Sea. According to the Japanese cephalopod authority, Madoka Sasaki (1929), this species is identical with *T. rhombus*. He based his conclusions on 7 specimens collected in Japanese waters and ranging in mantle length from 180.0 to 685.0 mm.

In 1947, Barnard, in a brief note recorded the stranding of a specimen at the Cape of Good Hope and in 1956 Rees and Maul reported a specimen with a mantle length of 350.0 mm., from Funchal, Madeira, the only previous record from the Atlantic Ocean.

Thysanoteuthis rhombus is a powerful squid, with heavy musculature, and is a cosmopolitan warm water species. Rees and Maul reported that the Madeiran specimen was from a school of about 20 that came close inshore, so they probably are accustomed to schooling. In schools they must be voracious predators. Sasaki quotes the Japanese fishermen as saying that they may leap high above the sea surface and one of his specimens was taken after it leaped into the bunt of a sail and fell to the deck. Nothing is known of their food habits although probably they feed upon small fish.

Despite the paucity of records of adult specimens, this is almost certainly a common pelagic species. A preliminary examination of the cephalopods collected by the *Dana* expeditions in the North Atlantic has revealed numbers of thysanoteuthid larvae and the

lack of capture of adults is probably due to their size and speed.

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XANTHONYCHIDAE (PULMONATA)

By H. BURRINGTON BAKER

Since the extension of priority to familial names has been ratified again at the 25th (1958) International Congress of Zoölogy, the status of the family term for American helicoids needs reconsideration. As pointed out 16 years ago (1943), the oldest name for an American "helicid" is Xanthonychidae (1879), which originally included only the Mexican genus *Xanthonyx* (1867). The following chronologic synopsis outlines the history of these and the related familial names (new ones in *italics*):

1867. Crosse, H. & Paul Fischer. J. de Conch. 15:212. *Xanthonyx*.
 1879. Strebel, Hermann & G. Pfeffer. Beitr. Kennt. Faun. mex., etc. 4:25. *Xanthonychidae* (misspelled until 1956).
 1883. Fischer. Man. de Conch. :469. *Xanthonyx* between Binneya & Helix in Helicidae.
 1884. Tryon, G. W./Struct. Syst. Conch. 3:57. *Xanthonyx* = Binneya in Helicidae.
 1890. Moellendorff, O. von. Bericht. Senckenberg. Ges. :226. *Cochlostylidae* ("type g." = *Helicostyla*; cf. 1909).
 1892. Pilsbry, H. A. Naut. 6:69, footnote. *Cochlostylidae* not acceptable.
 1898a. Mlldff. Abhandl. Ges. Gorlitz 22:97. *Eulotidae* ("type g." = *Fruticicola*; cf. 1927).
 1898b. Pilsbry & E. G. Vanatta. Proc. ANSP. 50: 229. Copied Tryon (1884) in Arionidae (Binneyinae).
 1900. Pilsbry. Proc. Malac. Soc. London 4:24. *Xanthonyx* in "Belogona Euadenia" (= *Eulotidae* of 1928).

1909. Ihering, H. von. Wien. Verh. Zool. Bot. Ges. 59:430. *Helicostylinae*.
1927. Lindholm, W. A. Archiv Molluskenk. 59:120. *Fruticicolidae*, 1 ("type g." = *Bradybaena*; cf. 1934).
1928. Hoffmann, H. Klass. Ordn. Tier-Reich., Pulmonata:1240. *Fruticicolinae*, 2 ("type g." = *Trichia*) in *Helicidae*. *Eulotidae* (p. 1239) with *Xanthonyx* as of "Unsicher Stellung," *Cepolinae* *Helicostylinae*, *Epiphragmophorinae* & *Lysinoinae*).
1929. Ihering. Abhandl. Archiv Molluskenk. 2: (2):50. *Fruticicolidae* (2). *Eulotinae* (p. 61) and *Cochlostylinae* (p. 70).
- 1931a. Hesse, Paul, Zoologica 31 (1½):105. *Fruticicolidae* (2).
- 1931b. Thiele, Johannes. Handb. Syst. Weichtierk., pt. 2:688. *Fruticicolidae* (1) with *Helicostylinae* and (p. 697) *Epiphragmophorinae* (*Xanthonyx* p. 698, & *Lysinoe*).
1934. Pilsbry. Proc. ANSP. 86:7. *Cepolidae* (*Bradybaeninae*).
1937. Rensch, Ilse. Arch. Naturgesch. 6 (4):576. *Eulotidae*. (Also M. Perrot, 1938, & G. Cherbonnier, 1943).
1939. Pilsbry. Land Moll. N. A., ANSP. Monogr. 3, vol. 1:24. *Helminthoglyptidae*, with *Xanthonyx*; *Cepoliinae* & *Sonorellinae* (p. 25) & *Humboldtianinae* (p. 26). *Bradybaenidae*, p. 15.
1943. Baker, H. B. Naut. 56:82, footnote. *Xanthonychidae* prior.
1948. Dalsum, J. van. Basteria 12:4. *Fruticicola* (2).
1952. Webb, Glenn. Gastropodia 1:1. *Xanthonychidae* adopted.
1953. Hosoi & Sone. *Eulota* (from Zool. Rec., Mollusca:20; p. 96 lists 3 uses, but none of *Fruticicola*).
1958. Turner, Ruth D. MCZ. Occas. Papers on Mollusks 2 (22): 153. *Fruticicolidae* (1).

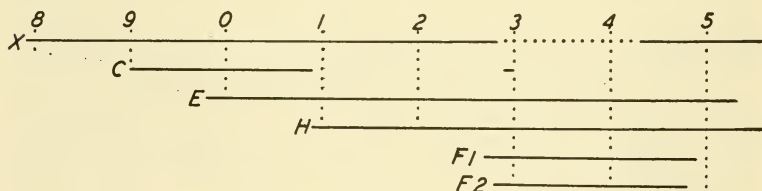


FIGURE 1. Duration of names (to 1956). 8 to 5 = decades (1880-1950). C = Cochlostylidae. E, F1 & F2 = Eulotidae & Fruticicolidae, 1 & 2 (to last citations in Zoo. Rec.): H = Helicostylinae. X = Xanthonychidae (dotted part = synonymy).

From the above (Cf. fig. 1), Xanthonychidae did drop out of sight for 64 years (1943), and was not adopted until 73 years (1952) after its proposal. However, so far as I can make out, even its "type genus" was not included under an applicable but subsequent, familial name until 1928, which may be taken to

mean that Xanthonychidae remained only 15 (or 24) years in the synonymy of any of these. Although *Xanthonyx* shifted after 1879 from Helicidae (1883) to the synonymy (1884) of an arionid (1898b), its generic status or inclusion in the helicoids has not been questioned since Pilsbry's (1900) dissections.

The only 2 applicable, family names, which had been in existence for 50 years before 1952, are Cochlostylidae (1890) and Eulotidae (1898). These were based, without descriptions, on synonyms of the Old World genera *Helicostyla* and *Fruticicola* (= *Bradybaena*), respectively, and did not include *Xanthonyx*. Cochlostylidae was repudiated when 2 years old (1892) and was submerged by Helicostylinae (1909) 50 years ago, although it bobbed up again once subsequently (1929). Eulotidae was adopted quite generally. After it was rejected (1927), its use by authorities (1928, 1929 & 1937) continued for at least 16 years, and its "type genus" apparently has remained in general use (1953).

The 5th name, Fruticicolidae (1), was substituted (1927) for Eulotidae, without mention of any American genus. It was (and still is) especially confusing, because *Fruticicola* (2) traditionally had been used instead of *Trichia* in what now is a distinct family (Hygromiidae Tryon, 1866) or a subfamily of Helicidae. In fact, the next year (1928) and afterwards (1929 & 1931a), Fruticicolidae (2), with the hygromiid sense (still used in 1948) of its "type genus," was preferred by the best European students of helicoids.

In Eulotidae, Hoffmann (1928) included *Xanthonyx*, as of "uncertain position," adopted Helicostylinae, and initiated for other American genera Cepolinae, Epiphragmophorinae and Lysinoinae (spelling corrected in 1929).

Unfortunately, Thiele (1931b) went back as far as the 1st (1927) confusing Fruticicolidae. He included in it Helicostylinae (1909) and also Epiphragmophorinae, in which he put *Xanthonyx*. Pilsbry (1939) substituted Bradybaenidae (-inae, 1934), partly to get rid of this confusion, but also because he judged *Fruticicola* to be congeneric with *Bradybaena*, as did Lindholm (1927). On the other hand, Turner (1958) copied Thiele.

Until his death, Dr. Pilsbry applied the old "rules" for synonymous "type genera," but thought priority for family (-idae)

names should be kept independent from that for subfamily (inae) terms. In 1939, when he grouped the American helicoids in a separate family, he found *Cepolidae* (1934) was a homonym. Unaware of *Xanthonychidae*, he quite logically (from his viewpoint) proposed *Helminthoglyptidae*, and the included *Cepoliinae* (his emendation), *Sonorellinae* and *Humboldtianinae*. He put *Xanthonyx* (by definition) in the typical subfamily, and it does approach *Monadenia* (cf. 1952). He did say: "*Epiphragmophora* Doering is an aberrant genus . . ."

The preceding study has proved that *Xanthonychidae* (1879) must be accepted for at least the native American genera of helicoids, under the present "rules." Its adoption provides one, quite considerable advantage. Since the sizes of families are matters of convenience and/or custom, we Americans, North and South, can leave to the wisdom of our Old World colleagues the advisability of a separate family for the genera of their home lands. When they become ready to choose its name, they also might determine the relative status of the typically European *Eulotidae* (1898) and of the primarily Philippine *Helicostylinae* (1909); both names are prior to either *Fruticicolidae* (1927 or 1928).

Incidentally, on the basis of counted citations in the 29 vols. of the Zoölogical Record since 1927, *Eulota* and/or *Eulotidae* remain in much more general use than *Fruticicola* and/or *Fruticicolidae* (both usages combined). The last 17 vols. (since 1939) contain 3 notices of *Eulota fruticum* (type species) and one of *Bradybaena fruticum*, by Caesar Boettger, but no usage in *Fruticicola*. Why not ask the International Commission to suppress completely *Fruticicola* Held, 1837, which is causing all this confusion?

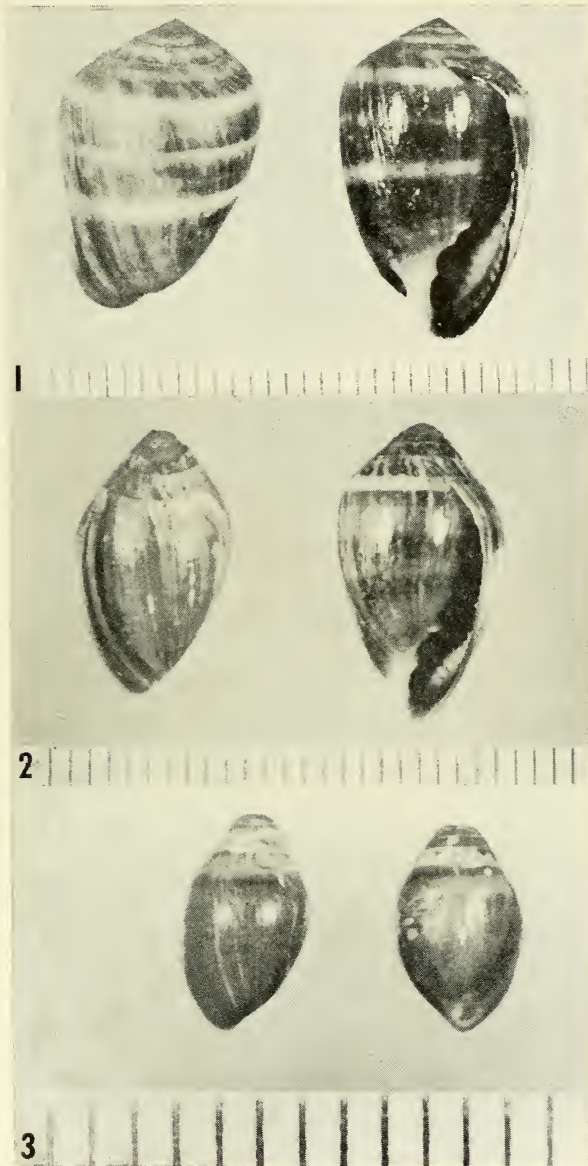
STUDIES ON THE GENUS *MELAMPUS* (PULMONATA)*

By PAUL A. HOLLE AND CLARENCE F. DINEEN

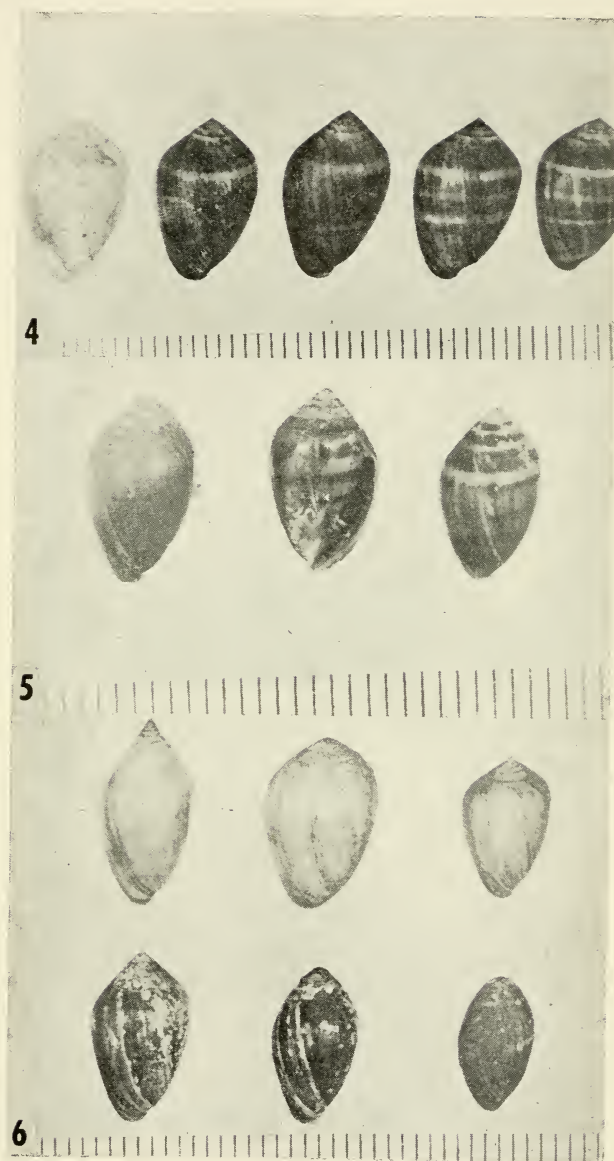
State Teachers College, Worcester, Mass., and
Saint Mary's College, Notre Dame, Ind.

The ellobiid genus *Melampus* was erected in 1810 by Montfort, for *Bulimus coniformis* Bruguière from French Guiana,

*This work is a portion of a dissertation by the senior author in partial fulfillment of the requirements for the degree of doctor of philosophy from the University of Notre Dame.



1, *Melampus coffeus* (L.). 2, *M. bidentatus* Say. 3, *M. floridanus* Shuttleworth. Scales in mm.



4, *Melampus* from Captiva Island, Florida (lot 37) illustrating varying no. of stripes (0 to 4). 5, Snails from Nags Head, North Carolina (lot 21) illustrating varying no. and width of stripes. 6, Snails from Stonington, Conn. (lot 12) illustrating variety of shapes, spires and spire angles. All scales in mm.

South America. Since 1810, several species that had been described earlier have been transferred to the genus *Melampus*, and many new species have been added. However, little agreement can be found on the relative status of the various species. Many have been reduced to synonymy.

Johnson (1934) recognized four species and two subspecies of *Melampus* along the east coast and Gulf Coast of the United States:

Melampus coffeus coffeus (L.), 1758 (Fig. 1).—Cedar Keys (Florida) to West Indies.

M. c. gundlachi Pfeiffer, 1853—Florida to West Indies.

M. flavus (Gmelin), 1789—Cedar Keys (Florida) to West Indies.

M. floridanus Shuttleworth, 1854-1856 (Fig. 3)—Maryland to Florida Keys.

M. lineatus Say, 1822 (Fig. 2)—Prince Edward Island, Canada, to the Gulf of Mexico.

Johnson listed these categories, without descriptions or a key, and we relied upon the original descriptions and redescriptions, upon such type specimens as are extant, and upon the distributional data in an effort to separate mixed collections of salt-marsh snails.

The essence of taxonomic separations is discontinuity, in structural features if possible, in habitat or behavior or geographical range, etc. In *Melampus* discontinuities are hard to find. This has led to a great deal of confusion, and to synonymizing in many ways. In the lengthy list of Pfeiffer (1856), curiously enough, was *M. lineatus* Say, and this usage must have been followed by Johnson. Since Say described *M. lineatus* as "Variety A" of *M. bidentatus* or as a possibly different species, *bidentatus* has priority in event that both names refer to the same species.

Based on fine differences in shell thickness and the degree of development of the plicae in the shell aperture (personal communication, 1953), Morrison (1950) recognized three subspecies of *M. bidentatus*:

M. b. bidentatus Say 1822—South Carolina to Florida and Texas; Tampico, Belize; Bahamas; Cuba; N. W. Jamaica; Gonave Id., Haiti; Tortola Id.?

M. b. lineatus Say 1822—New Jersey to North Carolina.

M. b. corneus (Deshayes) 1830—Prince Edward Island, Canada, to Staten Island, New York.

Morrison (1951) transferred *M. floridanus* to the genus *Detracia*.

With such taxonomic disagreement, it is easy to understand why distributional records are confused. Even records in other genera have been cited: thus, Hinkley (1907) identified as *Melampus floridanus* some snails collected in northeastern Mexico which Dall (Hinkley, 1907) identified as *Tralia cingulata*. Nor does Johnson's summary (1934) on range provide a solid foundation. He stated that *Melampus coffeus* was limited in range from Cedar Keys, Florida, to the West Indies; Pulley (1952) reported *M. coffeus* as the only species on the coast of Texas. Johnson (1934) either overlooked or disbelieved Hinkley's identification of *M. floridanus* from northeastern Mexico, since he gave the range limits of this species as Maryland to the Florida Keys. Johnson (1934) cited *M. bidentatus* (as *M. lineatus*) as extending from Prince Edward Island to the Gulf of Mexico, but did not indicate an exact limit along the Gulf of Mexico. Among collections studied by the senior author are specimens identified as *M. bidentatus* and/or *M. lineatus* from the coasts of the Gulf of Mexico and the Caribbean as far as Nicaragua. These collecting sites are reliably recorded, although the identifications are uncertain and therefore the range of the *bidentatus-lineatus* complex cannot be stated with finality.

The confusion between *M. bidentatus* Say, and *M. lineatus* Say, is particularly troublesome. Snails fitting Say's original description are abundant along the northeastern seaboard of North America. Under his diagnosis of *M. bidentatus*, however, he listed a "Variety A" as "very possibly a distinct species . . ." if so, it may be called "lineatus." To this day no worker has demonstrated clearly that *bidentatus* and *lineatus* are distinct—yet both names recur repeatedly in the literature.

According to Say's 1822 description, the type specimens of *M. bidentatus* and *M. lineatus* were in the collections of the "Academy and the Philadelphia Museum." All these specimens were not inherited by the Academy of Natural Sciences in Philadelphia, and a search by the senior author indicated that they have been lost.

Under these circumstances, the best approach appeared to be a thorough study of topotypes collected from localities along the

Lot #	Locality	Year collected	# of spec.	Size range (in mm.)
GROUP A				
1.	Prince Edward Island, Summerside	1953	50	5.0 - 11.5
3.	New Brunswick, Buctouche	1953	40	4.5 - 11.0
5.	New Hampshire, Rye Harbor	1951	166	5.5 - 14.0
9.	Massachusetts, Woods Hole	1955	156	4.0 - 12.0
12.	Connecticut, Stonington	1921	139	5.0 - 17.0
16.	Delaware, Indian River Inlet	1953	83	5.0 - 10.0
17.	Maryland, Cambridge	1953	232	4.0 - 12.5
20.	Virginia, Norfolk	1954	77	4.0 - 14.0
21.	North Carolina, Nags Head	1953	121	3.5 - 16.5
25.	Georgia, Brunswick	1953	59	3.5 - 9.5
26.	Florida, Fernandina		24	7.0 - 11.5
27.	" , St. Johns River	1874	13	9.0 - 10.5
28.	" , St. Augustine		7	7.0 - 10.5
29.	" , Ormond Beach	1934	291	6.0 - 15.0
34.	" , Key Largo	1953	57	7.5 - 16.0
37.	" , Captiva Island	1953	140	4.5 - 16.0
39.	" , Charlotte Harbor	1953	58	7.0 - 19.0
42.	" , Adams Beach	1952	19	6.5 - 14.0
46.	Louisiana, Grand Isle	1937	6	8.5 - 14.5
47.	" , Myrtle Grove	1931	23	10.0 - 15.0
48.	Texas, Matagorda		41	9.0 - 17.0
49.	" , Rockport	1953	45	9.0 - 13.5
50.	" , Port Isabel	1949	14	6.5 - 15.5
51.	Mexico, Campeche	1932	30	10.0 - 15.5
52.	Guatemala, Puerto Barrios	1935	67	6.5 - 12.0
53.	Nicaragua, Wounta	1944	24	8.0 - 13.5
55.	Bermuda, Hungary Bay	1903	40	10.5 - 21.0
58.	Bahamas, Cat Island	1935	61	8.0 - 16.0
63.	Cuba, Marial		59	2.5 - 19.0
67.	Haiti, Gonave Island		99	7.0 - 16.0
GROUP B				
15.	Delaware, Bombay Hook	1954	34	4.5 - 7.5
18.	Maryland, Cambridge	1953	181	3.0 - 8.0
24.	Georgia, Darien	1954	10	3.5 - 7.0
38.	Florida, Ft. Meyers		34	2.5 - 7.5
41.	" , Tampa Bay		182	2.5 - 6.0
44.	Alabama, Mobile		7	4.5 - 6.5
GROUP C				
32.	Florida, Coconut Grove	1936	16	7.0 - 12.5
54.	Bermuda	1903	22	4.5 - 13.5
57.	Bahamas, Bimini	1941	24	8.0 - 12.5
60.	" , Long Island	1936	98	7.0 - 12.5
65.	Swan Island, (Caribbean Sea)	1916	12	10.0 - 16.0
66.	Jamaica	1942	161	2.5 - 12.5
68.	S. Domingo, S. Barbara de Samana	1937	43	4.0 - 12.0

Table 1. Shells studied for shell characteristics.



	Lot #	A	B	C
GROUP A	1.	0	0	
	3.	0	0	
	5.	0	0	
	9.	0	0	
	12.	50	15	1 - 4
	16.	0	0	
	17.	22	0	
	20.	49	22	1 - 4
	21.	21	0	
	25.	0	0	
	26.	4	8	1 - 3
	27.	0	0	
	28.	0	0	
	29.	82	35	1 - 7
	34.	92	3	1 - 4
	37.	85	1	1 - 5
	39.	96	13	1 - 5
	42.	31	15	1 - 4
	46.	33	0	
	47.	47	52	1 - 6
	48.	60	0	
	49.	95	0	
	50.	71	0	
	51.	100	33	2 - 8
	52.	100	17	1 - 7
	53.	100	33	1 - 5
	55.	65	0	
	58.	100	11	1 - 3
	63.	67	5	2 - 5
	67.	96	6	3 - 4
GROUP B	15.	82	0	
	18.	40	0	
	24.	90	0	
	38.	88	0	
	41.	100	0	
	44.	100	0	
GROUP C	32.	100	0	
	54.	100	0	
	57.	100	0	
	60.	100	0	
	65.	100	0	
	66.	80	0	
	68.	97	0	

Table 2. Col. A - % of each lot having a 3rd denticle.
 " B - % of each lot having parietal ridges.
 " C - range in the number of parietal ridges.

	Lot #	%	% of striped specimens having			
			1	2	3	4
			stripes			
GROUP A	1.	70			3	97
	3.	65			11	89
	5.	16			3	97
	9.	39	3		8	89
	12.	2				100
	16.	19				100
	17.	9				100
	20.	14				100
	21.	12		61	6	33
	25.	13				100
	26.	0				
	27.	0				
	28.	28				100
	29.	31		1	2	97
	34.	64		3	35	62
	37.	98	1	2	12	85
	39.	94	1	20	23	56
	42.	5				100
	46.	16				100
	47.	0				
	48.	43				100
	49.	37	5			95
	50.	35				100
	51.	93		15	32	53
	52.	62		5	35	60
	53.	70	4	10	16	70
	55.	75		4	13	83
	58.	80	26	34	26	14
	63.	61		2	30	68
	67.	69	7	5	55	33
GROUP B	15.	100		100		
	18.	99		98	1	1
	24.	100		100		
	38.	100		100		
	41.	100		100		
	44.	100		100		
GROUP C	32.	43		42	58	
	54.	36			100	
	57.	37		33	66	
	60.	58		7	93	
	65.	41			100	
	66.	37		23	75	2
	68.	36		15	85	

Table 3. Stripes - % of each lot having stripes, and number.

	Lot #	A	B	C	D
GROUP A	1.	68	55 - 85	1	0 - 4
	3.	65	50 - 85	0	
	5.	75	60 - 95	90	0 - 9
	9.	71	60 - 95	92	0 - 7
	12.	90	55 - 115	100	1 - 13
	16.	74	60 - 95	91	0 - 6
	17.	77	60 - 95	95	0 - 12
	20.	80	60 - 100	100	2 - 13
	21.	84	65 - 105	100	1 - 11
	25.	102	75 - 115	100	2 - 9
	26.	74	60 - 85	100	3 - 7
	27.	85	75 - 100	100	5 - 14
	28.	90	75 - 105	100	5 - 16
	29.	78	60 - 105	100	1 - 14
	34.	107	90 - 120	100	1 - 15
	37.	98	80 - 110	92	0 - 19
	39.	114	95 - 125	93	0 - 19
	42.	88	80 - 110	100	4 - 10
	46.	81	70 - 95	100	6 - 11
	47.	78	70 - 90	100	6 - 13
	48.	79	60 - 95	100	6 - 13
	49.	88	80 - 100	100	3 - 16
	50.	77	60 - 100	100	2 - 11
	51.	98	80 - 120	100	9 - 15
	52.	95	75 - 125	100	8 - 18
	53.	100	90 - 125	100	5 - 19
	55.	76	65 - 105	99	3 - 14
	58.	94	70 - 115	100	6 - 16
	63.	98	75 - 125	70	1 - 20
	67.	90	75 - 110	100	1 - 15
GROUP B	15.	60	50 - 70	100	1 - 9
	18.	59	45 - 85	100	1 - 9
	24.	72	60 - 85	100	5 - 9
	38.	63	50 - 80	100	2 - 9
	41.	68	55 - 85	100	2 - 10
	44.	67	60 - 80	100	2 - 12
GROUP C	32.	86	65 - 110	100	7 - 12
	54.	86	65 - 110	100	4 - 10
	57.	85	75 - 110	100	7 - 11
	60.	90	75 - 110	100	5 - 11
	65.	87	75 - 105	100	6 - 9
	66.	86	65 - 105	88	0 - 11
	68.	89	75 - 105	100	6 - 9

Table 4. Angle of spire: Col. A - mean angle (in °) of all spires.

" B - range (in °).

Plicae: Col. C - % of lot having plicae.

" D - range.

Atlantic, Gulf of Mexico and Caribbean coasts from Canada to Central America.

Shell characteristics: Although 5,897 shells collected from 71 localities were carefully studied in an attempt to clarify the taxonomic difficulties, the data of only 43 selected localities are included in this report for the sake of brevity (Table 1).

Initially the shells of each lot (from each collecting site) were measured for length, and separated into $\frac{1}{2}$ mm. length groups, such as 5.0 to 5.4 mm., 5.5 to 5.9 mm. Using terminology primarily that of Abbott (1954), the following observations were made on each shell:

- 1, form and position of denticles;
- 2, presence and number of parietal ridges;
- 3, kind of striping, and the number of stripes;
- 4, angle of the spire;
- 5, presence and number of plicae on the inside of the lip.

An analysis of the data on these points showed that several characteristics occurred in regular combinations, and provided a basis for the separation of shells into three distinct groups. These characteristics were used to construct the following key:

- | | |
|---|---------|
| I. 2nd (parietal) denticle located immediately inside the shell aperture | 1 |
| 1. 3rd (parietal) denticle, when present, near the 1st (columellar) denticle, or plainly separated from (anterior to) the 2nd (parietal) denticle; parietal ridges present in some specimens; stripes 0-4, usually 4; angle of spire $50-125^{\circ}$ | Group A |
| 2. 3rd (parietal) denticle, when present, located close to or partly fused with the 2nd (parietal) denticle; parietal ridges absent; stripes 0-2, usually 2 and near the shoulder; angle of spire $45-85^{\circ}$ | Group B |
| II. 2nd (parietal) denticle located far inside the shell aperture | Group C |

(To be continued)

NOTES AND NEWS

DATES OF NAUTILUS.—Vol. 72, no. 1, pp. 1-36, pls. 1-4, was mailed July 21, 1958. No. 2, pp. 37-72, pls. 5-8, Oct. 1, 1958. No. 3, pp. 73-108, pls. 9-11, Jan. 15, 1959. No. 4, pp. 109-148, title page and indexes, pl. 12, April 2, 1959.—H. B. B.

ANOTHER RECORD OF *ARION ATER*.—While on a camping trip in 1937, Mrs. Chace and I stopped in a camp ground in the north-east section of Seattle. In scouting around for snails, I found an area of semi-marsh, probably pretty wet in the rainy season. Here I saw many large, rather chunky and spotted slugs, which I later found to be *Arion ater*, the European slug. This colony is known to several people locally, but apparently never has been reported in the literature.—E. P. CHACE.

CARYCHIUM CLAPPI, new name, for *Carychium costatum* Hubricht, 1951, Naut. 65:59, not *C. costatum* Freyer, 1856, Sitzber. K. K. Akad. Wissensch. (for) 1855, p. 20, pl. 1, fig. 5, = *Zospeum costatum*. The new name is proposed in honor of George Hubbard Clapp, who described it from Alabama, but did not name it (1906, Naut. 19:139).—LESLIE HUBRICHT.

UNIONID INTRODUCTION IN MASSACHUSETTS.—On September 8, 1958, the writer began an experiment in hybridization by introducing three midwestern unionid species into the Ipswich River drainage in eastern Massachusetts. Such introductions should be recorded.

The unionids, *Lampsilis radiata siliquoidea* (Barnes), *Anodonta grandis* Say, and *Elliptio dilatatus* (Raf.) were collected at Base Line Lake, Livingston Co., Michigan, by J. P. E. Morrison, P. F. Basch, J. B. Burch, H. J. Walter, and the writer. Adult specimens, 70 of *L. r. siliquoidea*, 16 of *A. grandis*, and 7 of *E. dilatatus*, were placed in a small, recently created lake near the Valley Road in the Putnamville section of Danvers, Essex Co. and 66 of *L. r. siliquoidea* were placed in Silver Lake, Wilmington, Middlesex Co. The writer intends to introduce equivalent numbers of *L. r. radiata* (Gmelin), *A. cataracta* Say, and *E. complanatus* (Sol.) at the Danvers locality in the spring of 1959 and to observe the lake in succeeding years for possible further evidence¹ of gene flow between related groups. This lake apparently contained no unionids prior to this introduction. The Wilmington locality contained only *A. cataracta* and *E. complanatus* before the *Lampsilis* introduction and I hope that it will serve as a control to reveal possible phenotypic changes in

¹Clarke, A. H., Jr., 1958, American Malacological Union Annual Reports for 1957, pp. 15-16.

L. r. siliquoidea, resulting from the lower calcium carbonate content of eastern Massachusetts water. Both of these new localities contain many species of fish and are similar to Base Line Lake in physical ecology.—ARTHUR H. CLARKE, JR.

RUMINA DECOLLATA IN OKLAHOMA.²—On 12 January, 1959, Mr. R. C. Harrel found several specimens of *R. decollata* (L.) under an iron pipe lying on moist, sandy soil near Ada, Pontotoc County, Oklahoma. Three of these specimens were subsequently sent to the author as a gift from Dr. C. J. Dennis, of East Central State College, Ada. To my knowledge this is the first record for this species in Oklahoma. Pontotoc County is in mid-southern Oklahoma and lies in the so-called Texan biological province. This particular part of Oklahoma is characterized by low, rolling hills, sandy soil, oak-hickory associations along streams and cross-timbers on the hills.

The specimens represented several stages of growth, from small and immature to large, fully adult, living snails. The three specimens sent to Oklahoma State University measured 27.5, 28.0, and 14.0 mm. in total length. The apical whorls were decollated from each specimen.

Seemingly in many places this species, where it has been introduced by the activities of man, has become very numerous and often a pest. Last July (1958) I found it to be one of the more common species in Zilker Park, Austin, and rather abundant on the banks of the San Gabriel River, Georgetown, Williamson County, both in Texas. These snails are very easily transported in greenhouse materials. In 1948, 15 February, several specimens of the snail were found around the roots of a shipment of violets from Fort Worth, Texas. Supposedly, this, or some similar vehicle, is the route via which *Rumina* entered southern Oklahoma, after which it escaped. Whether it will be successful is academic.—BRANLEY A. BRANSON.

LIGUUS HATCHED.—I just want to let you know that my first egg from *Liguus* was hatched April 10. From all I know, this is the first time, while in captivity. This winter, I collected 2 live *pictus* in Florida.—R. ATMUS (from letter).

²Contribution 292 from the Zoology Department and the Research Foundation, Oklahoma State University, Stillwater.

NORTH DAKOTA.—Is anyone interested in receiving snails or slugs? If so, I would save specimens for a taxonomist. I do not know if anyone ever concentrated on North Dakota mollusks.—R. L. Post, N. D. Agricultural College, Dept. of Entomology, Fargo, North Dakota.

PUBLICATIONS RECEIVED

THE GASTROPOD GENUS *ASSIMINEA* in the Philippines. By R. Tucker Abbott. Proc. Acad. Nat. Sci. Philadelphia 110:213-278, pls. 15-25. 1958.—This studies the anatomy, ecology, habits and geographic distribution of 21 species (4 new) and subspecies (2 new) from the Islands and adjacent areas. The very dubious *Syncera* (literally hearty or sound!) is rejected for the genus, and the various sections, which have been proposed, are considered artificial or unusable groups. A "Catalog of names connected with *Assimineae*" covers the world. But, does not *Assimineidae* date from 1856, instead of 1858 (pp. 215 & 265)? Incidentally, "Synceratidae" Bartsch was corrected to *Synceridae* by Pilsbry & Bequaert, 1927.—H. B. B.

DISTRIBUTION AND VARIATION of the Hawaiian tree snail *Achatinella bulimoides* Swainson on the windward slope of the Koolau Range, Oahu. By d'Alte A. Welch. Proc. Acad. Nat. Sci. Philadelphia 110:123-211, figs. 1-2, pls. 10-14. 1958.—In this continuation of exhaustive studies on variation, especially of color forms, in a species, which has a range of 72 square miles, 5 subspecies are proposed as new. These beautiful shells are represented now by rapidly vanishing, relict colonies or "demes" on the ridges, which are outlined on maps.—H. B. B.

STUDIES ON THE BIOLOGICAL CONTROL OF SCHISTOSOME-BEARING SNAILS. I. The control of *Australorbis glabratus* populations by the snail, *Marisa cornuarietis*, under laboratory conditions.—II. Ditto, by the leech, *Helobdella fusca*. By Eli Chernin, Edward H. Michelson & Donald L. Augustine. Amer. J. Trop. Med. & Hygiene 5 (2):297-307; 308-314. 1956.—III. The effects of population density on growth and fecundity in *Australorbis glabratus*.—IV. Further observations, etc. By Chernin & Michelson. Amer. J. Hygiene 65 (1):57-70; 71-80. 1957.—V. Ditto I, of *Biomphalaria*

pfeifferi. By Michelson & Augustine. J. Parasit. 43 (2):135. 1957.—The ampullariid ingested eggs and the leech attacked juveniles especially. Crowding apparently inhibited population growth.—H. B. B.

NOTES SUR LES LIMACES. Philomycidae et Limacidae de la république El Salvador. By C. O. van Regteren Altena. Arch. Mollusk. 87 (1/3):27-31, 2 figs. 1958.—Middle American records are added for *Pallifera costaricensis* (variations in color pattern and penis figured) and *Deroceas laeve*.—H. B. B.

ON THE STRUCTURE OF COPULATIVE APPARATUS of *Hippeutis complanatus* (L.). By Ja. I. Starabogatov. Zool. Zhyr. Ak. Nauk SSSR. 37 (11):1743-4, 1 fig. 1958.—This planorbid has a lateral (not apical) opening in its verge (penial papilla), and the inclusion of it (and maybe *Hippeutis* also) in the genus *Segmentina* is suggested.—H. B. B.

DESCRIPCION DE UNA ESPECIE NUEVA de *Pomacea* de Venezuela. By T. Pain & Sergio Arias C. Nov. Cien. Ser. Zool. (Caracas) 24:5-11, pls. 1-2. 1958.—*P. falconensis* from Chichiriviche, Falcón, with male anatomy. Apparently its type locality is about 20 miles from that selected for *P. chemnitzii* in 1930.—H. B. B.

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No. 2

AN UNUSUAL OCCURRENCE OF *MYA ARENARIA* L. AND NOTES ON OTHER MARINE MOLLUSKS

By ARTHUR S. MERRILL

U. S. Fish and Wildlife Service, Woods Hole, Mass.

Many species of mollusks having a pelagic larval stage settle upon navigation buoys. These buoys are brought in periodically for maintenance, at which time the attached species can be collected. This paper is the result of sampling one such buoy at the Coast Guard Station, Woods Hole, Massachusetts.

On June 14, 1956, the Coxen's Ledge lighted bell buoy was placed on station in Buzzards Bay Channel midway between Gooseberry Neck and Cuttyhunk, Massachusetts (Latitude 41° 27' 00" N. and Longitude 70° 59' 20" W.), and on June 13, 1958, just two years later, it was brought in for servicing. The buoy is of the type equipped with a hollow cylindrical stabilizing tube. The inner surfaces of these tubes provide a sheltered area (*see* arrow, figure 1) for many species of animals and plants possibly unable to withstand the rigors of existence on the outside of the buoy. When the buoy was examined, two large specimens of the softshell clam, *Mya arenaria* L., were found far up in the stabilizer tube nestled in a thick growth of hydroids. Several other species of mollusks were collected at the same time. These are listed and discussed briefly.

The normal habitat of the soft-shell clam is within the mud or sand of the bottom. Our records show that small *Mya* have been taken from many buoys. To my knowledge, none approaching the size I took from this buoy have been reported. Furthermore, the length of these two specimens averaged 70.0 mm. which exceeds the normal growth of a two-year-old clam in its usual habitat. To evaluate the significance of this find, it is desirable to review briefly some biological aspects of this species.

According to Turner (1953), the preferred habitat of *Mya* is generally the upper estuary, although it is found at the heads of bays and in inlets along the lower estuarine zone where there is no significant reduction in salinity. Verrill and Smith (1873)

record softshell clams from the half-tide mark to depths of 40 fathoms, although only smaller clams have been dredged from the greater depths.

The time at which *M. arenaria* spawns and the duration of the pelagic larval stage are functions of temperature (Turner, 1948). Spawning may begin before May in Wickford Harbor, Rhode Island (Landers, 1954), or as late as August in Malpeque, Prince Edward Island (Stafford, 1912). Metamorphosis may be complete in 12 days or require as long as three weeks. As far as can be determined from the evidence at hand, spawning in the Buzzards Bay area takes place about the time the buoy was placed on station in June, so probably the *Mya* spat settled in it soon after it was put out.

After metamorphosis, the tiny clams usually settle to the bottom and, by means of a byssus, temporarily attach to sand grains, rocks, seaweed or shell (Turner, 1949). They usually burrow into the substrate and take up the sedentary phase of their existence by the time they are about 25 mm. long.

Th large specimens we collected from the buoy were apparently able to survive out of their usual environment because of the chance protection and support offered by the hydroids and other growths within the tube. Probably most of the small clams which attach to buoys fall to the sea bottom, possibly even before losing the power of byssal attachment. Probably these two specimens were the sole survivors of an initially large set. They not only survived but grew to a larger size than is usual under normal conditions.

Newcombe (1935) was able to determine age and the rate of growth of the soft-shell clam by counting and measuring the "annual rings" on the shell valves. In the cold Bay of Fundy waters, he found a two-inch clam to be about five years of age. Turner (1949) notes that *Mya* in Massachusetts waters grows two inches (50 mm.) in two to two and a half years, after which time growth becomes significantly slower.

I attempted to read the annual rings on the two specimens, and the measurements of these rings are as follows:

Spawned—June 1956	Specimen #1	Specimen #2
1st winter ring	30.2 mm.	26.5 mm.
2nd winter ring	58.3 mm.	60.4 mm.
Captured—June 1958	68.0 mm.	72.2 mm.

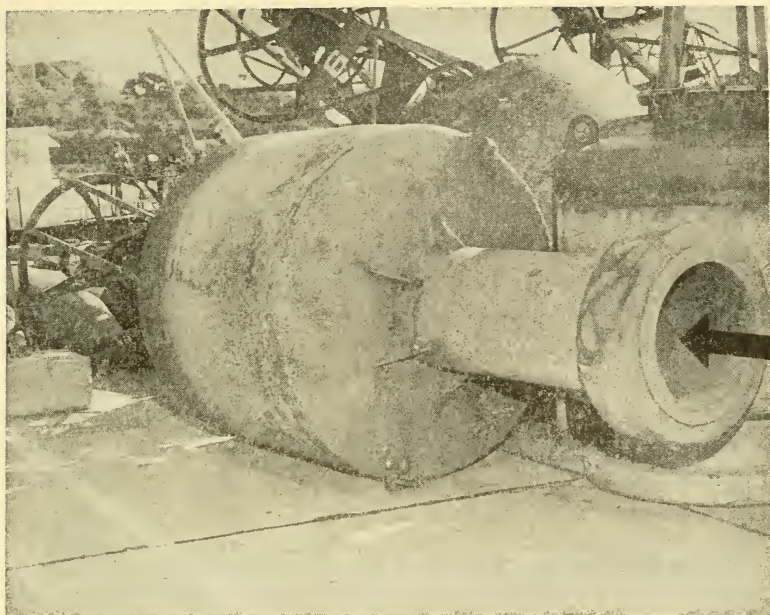


Figure 1. Sample navigation buoy. Arrow indicates the sheltered inner portion of the stabilizer tube, from which the mollusks were taken.

If my aging is correct, the clams were over two inches (50 mm.), the minimum legal size in Massachusetts, by the time they were a year and a half old, whereas in this area they do not usually reach this size until about a year later.

Investigators have studied and compared the growth rate of *Mya* and of other commercial bivalves both in their natural habitat and under conditions similar to those found in buoys. Belding (1915) suspended soft-shell clams in boxes at various depths from a raft. He compared these with clams grown in boxes buried to the level of the substrate in the shallow water near the shore. Clams suspended from the raft grew faster, and this he attributed to the faster current. Mossop (1921) secured a number of blocks bearing mussels (*Mytilus edulis* L.) to an anchored buoy and found that the greatest rate of growth occurred near the surface of the water. In Europe, where mussel farming is practiced extensively, a faster growth is found in those cultivated on wooden frames above the sea bottom. Quayle (1956) found that the raft method of oyster culture greatly enhanced the

growth of the suspended oysters. He further noted that this method results in lower mortality because it eliminates silting and reduces predation.

Belding (1930) considered the most important factor in clam growth to be a good current which carries food, oxygen and salts and acts as a sanitary agent. That this condition is met in the surface waters offshore where buoys are located is evident not only by the fast growth recorded for *Mya* in this particular buoy but also for *Mytilus* and many other species of mollusks from this and other buoys.

The mollusks collected in the Coxen's Ledge buoy are listed below. Included are notes on the frequency of occurrence of the species to this particular buoy, measurements of the smallest and largest specimen found for each species, and, where possible, the number of year classes represented according to our interpretation.

Mya arenaria Linné: very rare. Two specimens of the following height and length: 41.6×68.0 mm. and 42.2×72.2 mm.

Anomia simplex d'Orbigny: abundant. Largest 27.6 mm., smallest 6.4 mm. in height. There seem to be two year classes, one from about 20-27.6 mm., the other 6.4 to 12.0 mm.

Hiatella arctica (Linné): rare. Largest 17.0 mm. in length. Rare in this buoy but usually not at all uncommon when found in buoys.

Mytilus edulis Linné: most abundant. Largest 71.5 mm., smallest 2.0 mm. in height. Three year classes as follows:

Spawned 1956, 50.0-71.5 mm.

Spawned 1957, 20.0-40.0 mm.

Spawned 1958, 2.0-15.0 mm.

Mitrella lunata (Say): abundant. Little range in size, average 4.0 mm. in length.

Crepidula fornicata (Linné): common. 5.6-28.5 mm. in height. Two year classes, one from about 19.0 to 28.5 mm., the other 5.6 to 13.0 mm.

Crepidula plana Say: fairly abundant. 20.7-27.0 mm. in height. Apparently only one year class represented.

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A NEW BERINGIUS FROM THE PACIFIC NORTHWEST, WITH COMMENTS ON CERTAIN DESCRIBED FORMS

BY ALLYN G. SMITH

(Concluded from July no.)

The single, well preserved specimen from Chignik, Alaska, in Mr. Eyerdam's collection is comparable in general aspect and sculptural characters to the normal form from off the Washington coast on which the holotype description is based. There are 14 major spiral ribs on the body whorl and 8 each on the penultimate and antepenultimate whorls. Nuclear whorls and operculum

are missing. Mr. Norberg's specimen in the Tromsøe Museum is said to be similar, as is the single specimen in the San Diego Museum from off Vancouver Island.

Mr. Eyerdam's single shell from Raspberry Island, Alaska (C.A.S. No. 36319), is a large "dead" specimen with sculptural characters that are intermediate between the first of the two aberrant shells from the type lot described above (pl. 3, fig. 2) and the other heavily ribbed specimens. It is illustrated on pl. 3, fig. 4. This shell is cream-white, covered in places with a blackish-brown periostracum. Nuclear whorls are missing. The summits of the postnuclear whorls descend somewhat into the sutures. Spiral sculpture consists on the penultimate and early post-nuclear whorls of 3, strong, rounded cords on the lower half and several other less prominent ones that become progressively fainter above the periphery and fade out entirely at the tabulate summits. On the body whorl are about 8 fairly strong spiral cords below the periphery, which, with their corresponding interspaces, widen toward the outer lip. Above these the spiral cords become more or less obsolete; below them is the usual series of 8 smaller cords on the outer canal. Overall microsculpture consists of many fine, closely spaced spiral lines crossed by a series of equally fine, somewhat less closely spaced and less regular growth riblets that are weakly nodulose or beaded at the points of crossing. The low, rounded boss inside the upper end of the aperture is present.

The single shell from Bainbridge Island in Puget Sound, collected by Mr. Eyerdam, is a worn, "dead" specimen that is solid and heavy in texture but relatively smooth over-all, without any traces of heavy spiral ribbing whatever. Sculpturally it is much like the second of Mr. Stiles' aberrant specimens (pl. 3, fig. 3), having two widely spaced, subobsolete cords above the periphery of the body whorl with indications of several still weaker ones below. The outer canal, which is somewhat worn, has several (at least two and possibly more) weakly incised grooves. The upper portions of the earlier whorls descend somewhat into the sutures; the summit of the body whorl, however, is not tabulate and slopes downward in a straight line to the point where the rounded portion of the whorl begins. The maze of weak, protractive cording on the upper part of the body whorl, which is

present on the second of Mr. Stiles' aberrant shells, also occurs on this specimen. The outer lip is thick and slightly recurved at its middle part. There is a small siphonal fasciole.

Measurements of the series of shells at hand yield the following comparative data:

Specimens	Length ²	Max. Diam.	L/D	No. of whorls
10 adult shells from the type lot (extremes)	113.9 128.1	65.6 76.6	1.5 1.7	4¼ 5
Chignik, Alaska; sculpture normal	118.8	72.4	1.6	5
Vancouver Id., British Columbia; sculpture normal	109.0	67.5	1.6	4¾
Aberrant shell from type lot; spiral sculpture obsolete	99.9	68.7	1.5	4
Aberrant shell from type lot; spiral sculpture stronger	117.2	68.0	1.7	4½
Bainbridge Id., Puget Sound; sculpture like preceding	123.9	72.4	1.6	6
Raspberry Id., Alaska; spiral sculpture intermediate	132.8	82.5	1.6	5½

In view of the fact that considerable variation may exist between shells of the same species in this family of marine, carnivorous mollusks, probably all the specimens from the general vicinity of La Perouse Bank, for the present at least, should be placed in the same species of *Beringius*. There is little doubt that earlier workers in the group, based on single shells coming in separately, would have described at least two and perhaps three species among the material now at hand. Because of the known variation in shells from the type lot it seems wiser to take the conservative step of naming only one species. As more shells become available, however, a change in this approach may be indicated. The existence of two specimens, one from the type lot with relatively smooth sculpture and another quite similar shell from Puget Sound present a puzzle in speciation that cannot be solved without more material. As should be pointed out, the animals in two of the heavily ribbed normal shells prove to be females. Whether specimens with male animals will show sculp-

²No attempt has been made to estimate the length or number of lost nuclear whorls. Dimensions are in mm.

tural and other differences in their shells that are constant is also a question for the future to answer.

Beringius eyerdami is most closely related to *B. undatus* Dall but differs in possessing a more globose shell with a shorter spire and particularly in the far more strongly developed spiral ribs and channels. It is named for Walter J. Eyerdam in recognition of his many contributions to the knowledge of conchology and for the fact that he furnished the first specimen of this new species several years ago.

Thanks are due to my associates, Drs. G. Dallas Hanna and Leo G. Hertlein for advice and assistance with the manuscript. The excellent photographs used for illustrations are the work of Mr. E. C. Crompton, the California Academy's photographer.

STUDIES ON THE GENUS MELAMPUS (PULMONATA)

BY PAUL A. HOLLE AND CLARENCE F. DINEEN

(Concluded from July no.)

Denticles in the aperture. All shells possess at least two conspicuous denticles in the aperture; a columellar (1st) denticle and a parietal (2nd) denticle. An additional parietal denticle (3rd) is present in some shells (Table 2A).

The 1st denticle varies little, but the variation in the shape and position of the 2nd denticle proved significant. In groups A and B it is located immediately inside the shell aperture, whereas in group C it appears much farther inside and greatly facilitates identification of the latter group.

The 3rd denticle is subject to wide variation, its position appears meaningful, and it may be present or absent. Thus when present in specimens of group A, it consists of a rounded tubercle adjacent to or partially fused to the 2nd denticle. In group A, the percentage of specimens possessing the 3rd denticle was greater in the southern localities (Table 2A). When present in specimens of groups B and C, it is rounded and plainly separated from (anterior to) the 2nd denticle. The incidence of this 3rd denticle remained consistently high in all habitats south of east-central Florida. A large percentage of specimens in lots of group B possessed a 3rd denticle, although the incidence was somewhat lower in lots from northern localities. The incidence of the 3rd denticle

in group C is consistently high. All shells of group C came from southern localities. Consequently, the presence of the 3rd denticle is correlated with latitude.

Parietal ridges. Low, limy elevations toward the posterior end on the columellar side of the aperture were present only in some specimens of group A and varied in the number per shell (Table 2B, 2C). In general parietal ridges were more prevalent in southern populations.

Stripes. In this study, only the pale stripes between the shoulder and columellar denticle on the apertural side were counted. The percentages of specimens in each lot having stripes, and the variation in number of stripes, are shown in Table 3. In group A, the incidence of striped specimens varied erratically from lot to lot, but most stripe-bearing specimens had 4 stripes. The number of stripes in some lots of group A varied from 0-4, (pl. 6, fig. 4). Both the number and width of the stripes varied (fig. 5). Nearly all specimens of group B had 2 stripes. Group C with few exceptions had 2 or 3 stripes; a majority had 3 stripes.

Angle of spire. The average angle of all specimens in each lot is given in Table 4. The range in spire angles is wide even among specimens from a single locality (fig. 6). For group A, the average angle of the spire increases gradually from north to south. For groups B and C, the average angle varies little for shells from all localities.

Plicae on inside of lip. Some of the shells possessed ridges or plicae on the inside of the lip. The percentages of shells in each lot having plicae, and the numerical range, are given in Table 4.

In group A, all specimens (except those from extreme northern localities) possessed plicae. All specimens of group B and almost all group C possessed plicae, but no geographical nor ecological pattern could be found among those of group C lacking this structure.

If Dall's (1894) explanation for plicae is correct, it is easy to understand why there would be considerable variation in this characteristic. According to Dall, the columellar attachment of snail shells without spirals is as long as the mantle edge, so that withdrawal into the aperture results in little to no wrinkling or folding. In forms with strong spirals, such as *Melampus*, by contrast, the attachment area is narrow and separate from the aper-

ture. As a result, the distal edge of the mantle is folded during withdrawal — comparable to the wrinkling of a flattened napkin when being pulled through a ring. Minerals deposited by the wrinkled mantle edge would follow its contours and form plicae.

DISCUSSION AND SUMMARY

Confusion concerning the genus *Melampus* appears due to difficulties in identifying these snails along traditional lines. Shell structure is variable. The distribution of each species overlaps others. Life history information has been scarce or lacking altogether (Morrison, 1950).

As a result of this study of shell structure, two of the five categories listed by Johnson (1934) are readily identified:

Melampus floridanus (pl. 5, fig. 3), discussed previously as "Group B," is segregated on the basis of three features: (1) the anterior position of the 3rd denticle; (2) its small size (less than 8.5 mm.); and (3) two chestnut stripes near the shoulder. On the basis of habitat study, it would seem that this species can tolerate low salinity, hence can be found greater distances from sea water, especially in the upper portions of streams draining into salt marshes.

Melampus flavus, discussed previously as "Group C," is segregated on the basis of three features: (1) the anterior position of the 3rd denticle; (2) the internal position of the parietal denticle; and (3) the presence of three stripes in a majority of striped specimens. Habitat studies indicate that this species frequents areas which remain submerged by sea water for long periods. They are often found in rocky areas. In this vigorous environment they have developed a harder, thicker shell.

Group A has been more resistant to analysis. A study of shell characteristics and interpretation of habitat and distribution data suggest three possibilities: (1) that these snails all belong to a single species of wide variability, this variation showing some local features (perhaps as clones) and some correlation with latitude; (2) that these snails belong to two species, a northern and a southern, the ranges of which overlap along the middle eastern coast of Florida; or (3) there are two species, a northern and a southern, with no outliers of the southern species north of Florida but with outliers of the northern species in southern localities.

If further facts support the first possibility (i.e., all in a single species), then all members of Group A should be called *Melampus coffeus*. If the second and third possibilities should prove valid, then the southern form would be called *M. coffeus* (pl. 5, fig. 1), the northern form *M. bidentatus* (fig. 2)

The first possibility is supported by the following:

1. All members have both a columellar and parietal denticle, with the third denticle becoming more prevalent in southern portions of the range (Table 2A).
2. The presence of parietal ridges increases in the more southern areas (Table 2B).
3. The number of stripes does not exceed 4, with 4 being the most prevalent number in the northern populations, but gradually becoming variable in southern populations (Table 3).
4. The angle of the spire changes gradually from acute in the north to obtuse in the south (Table 4A).
5. The number of plicae is highly variable but increasing in number from north to south (Table 4C).

The second possibility (two species, a northern and southern, the ranges of which overlap along the middle eastern coast of Florida), is supported by the following:

1. The percentage of specimens having a third denticle (Table 2A) and parietal ridges (Table 2B) remains nil in most populations until the populations of northeastern Florida are considered.
2. The number of stripes in specimens north of Florida is primarily four, while the southern forms tend to be erratic (Table 3).
3. The spire angle of specimens north of Florida remains essentially very small, tending to be greater in the more southern forms (Table 4A).

The third possibility (two species, a northern and southern, with no outliers of the southern species north of Florida but with outliers of the northern species in southern localities) is suggested by a number of lots studied. They are:

1. Lots 27 and 28 lack a third denticle (Table 2A).
2. Lots 27-28, 48-50 lack parietal ridges (Table 2B).
3. Lots 28, 46, 48-50 contain specimens most of which have four stripes (Table 3), and have very small spire angles (Table 4A).
4. Collecting data, when available, suggest that the northern and southern forms prefer different habitats—the former preferring a grassy habitat as opposed to mangrove areas for the southern form.

Resolution of the three possibilities will require additional studies, especially habitat and life history studies (as was suggested by Morrison, 1950).

As a result of the present study, however, several points have been clarified:

1. Three different species of *Melampus* can be distinguished among the salt-marsh snails of the Atlantic coast, the Gulf of Mexico, the Caribbean, and Bermuda:

M. coffeus (L): From the east central coast of Florida southward, including the Gulf of Mexico, the Caribbean and islands of the West Indies, and Bermuda; *M. bidentatus* may be a synonym, or a subspecies, or a separate species, with range extending from Georgia northward to the Maritime Provinces of Canada.

M. flavus (Gmelin): From the east central coast of Florida southward, including the Gulf of Mexico, the Caribbean and islands of the West Indies, and Bermuda.

M. floridanus Pfeiffer: From Chesapeake Bay southward, including the Gulf of Mexico.

2. In the event that future study demonstrates the duality of "Group A" and hence the need for a second name, *M. bidentatus* is available and should have priority over *M. lineatus*. As was suggested by Pilsbry (1927), no reason is apparent for considering it preoccupied.

3. Variability in the characteristics used by Morrison (1950) in separating subspecies of *M. bidentatus* appears continuous enough that his subdivision seems inadvisable; geographical distribution of the varieties he recognized shows no discontinuities that would urge retention of the subspecific names.

4. The specific name *M. floridanus* should be credited to Pfeiffer (1856), not Shuttleworth. The 1854 monograph by Adams and Adams lists this specific name but gives no description. According to Dr. William Clench (personal communication), a Mr. Rugel collected the original Florida specimens for Shuttleworth, and they are now part of the Cuming Collection in the British Museum (Natural History). Neither Rugel nor Shuttleworth described the specimens; both merely gave them museum numbers. Hence *floridanus* remained a *nomen nudum* until Pfeiffer validated it in 1856. As a matter of courtesy, and an index to its frequent appearance in literature, it could also be *M. floridanus* "Shuttleworth" Pfr.

5. Until specimens from Cayo Blanco, Cuba, have been studied and found to match Pfeiffer's (1853) description of *M. gundlachi*, this name well may be left as *incertae sedis*.

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PLEISTOCENE MOLLUSCAN NOTES, II
FAUNULE FROM HUNTINGTON BEACH MESA, CALIF.

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Huntington Beach Mesa is one of a series of low mesas and plains developed along the coast between Palos Verdes Hills and San Joaquin Hills, California. To the south, it is separated from Newport Mesa by the Santa Ana Gap, and to the north, from

the small Bolsa Chica Mesa by Bolsa Gap (Poland, Piper *et al.*, 1956, pl. 1). These mesas lie athwart the Newport-Inglewood structural zone, and their surfaces are commonly deformed. Poland, Piper *et al.* (1956) suggest that they represent remnants of a formerly widespread surface correlative with the surface of the Upper Pleistocene Palos Verdes sand.

Marine sediments exposed in stream-cut bluffs and in gravel pits below the surface of Huntington Beach Mesa have been assigned to the Lower Pleistocene San Pedro sand (Poland, Piper *et al.*, 1956, pp. 62-62, pl. 3). However, Mr. Robert G. Thomas has recently discovered marine fossils in these sediments, and they indicate an Upper Pleistocene age.

Marine sands and gravels are exposed in a sand pit about 2 miles north of the city of Huntington Beach, Orange County, California (see Description of fossil localities, to follow). Mollusk shells are locally abundant in several lenses, but are in poor condition, being chiefly broken and also leached by ground water. Collections made from three localities in the sand pit (UCLA. localities 3655, 3656, and 3657) contain a total of 47 species that can be identified definitely and 9 more that may only be compared or referred to described species or genera, because of their fragmentary condition (table 1).

The identified mollusks all represent species that are living today. Recent populations of most of them live on sandy substrates and along exposed sandy beaches. Only a few species, as *Tegula ligulata* and *Megatebennus bimaculatus*, probably require a solid substratum, and these species are rare in the collections. The most abundant species (for which ecologic data are available) are exposed sandy beach forms, as *Tivela* and *Donax*, and slightly deeper-water forms that are common along exposed coasts on relatively coarse, current swept or wave-agitated bottoms, as *Glycymeris subobsoleta*, *Tellina salmonea*, and *Spisula planulata*. These assemblages evidently represent depths of less than about 5 fathoms along an exposed coast. The sediments are lenses of medium to coarse cross-bedded sands and pebble and cobble gravels and also suggest deposition in agitated shallow water. The collection from UCLA. Locality 3655, composed of fewer species and of relatively more exposed sandy shore species than the other two, probably represents a beach

deposit; perhaps the other fossils are in beach deposits also.

Two species are present that live today only well to the south, where they form part of a northward extension of the Panamanian fauna that inhabits embayments along southwestern Baja California, Mexico. These are *Crassinella branneri* and *Petricola parallela*. These species are both present in the Palos Verdes sand at San Pedro, California, but are not known in Lower Pleistocene deposits.

C. branneri is known to live from Laguna Scammon, Baja California (Woodring *et al.*, 1946, p. 88) to Corinto, Nicaragua (Eyerdam in Burch *et al.*, 1944, no. 39, p. 9). Possibly, *C. branneri* is conspecific with the Recent *C. pacifica*, which has essentially the same recorded geographic range. *C. branneri* is particularly characteristic of warm-water facies of the Upper Pleistocene in southern California, wherein it is recorded from Pacific Palisades, California (Valentine, 1956, p. 195) to Bahia San Quintin, Baja California (Orcutt, 1921), chiefly in moderately protected shallow inner sublittoral facies but also in exposed-shore facies. A single Recent record of *branneri* from San Diego (Dall, 1921, p. 31) is probably based on fossil material (as was the case with *Dosinia ponderosa*; see Woodring *et al.*, 1946, p. 84, footnote 81a).

Petricola parallela is known to live from Laguna Scammon, Baja California (Hertlein and Strong, 1948, p. 195) to Corinto, Nicaragua (Pilsbry and Lowe, 1932, p. 99), from the littoral zone to 8 fathoms. In the Upper Pleistocene, it is recorded from San Pedro (U.C.L.A. collections) to near Newport Beach, California (Bruff, 1946, p. 232) chiefly in protected shallow-water facies.

A single specimen in the collections represents *Tegula brunnea*, which lives only to northward in the Oregonian province today. This species is characteristic of exposed rocky-shore facies of the Upper Pleistocene in southern California, but is recorded in other Upper Pleistocene facies and also in the Lower Pleistocene. In the Upper Pleistocene, it usually is associated with other Oregonian rocky-shore species to form a distinctive cool-water element. *T. brunnea* commonly lives somewhat offshore near the surface on kelp (Smith and Gordon, 1948, p. 201) as well as inter- and sub-tidally on rocks. Shells of *brun-*

nea in the essentially sandy-bottom, warm water association at Huntington Beach Mesa well may have been transported from kelp beds offshore in cooler water, perhaps on broken kelp fronds.

No species that are characteristic of the Lower Pleistocene are found in the collections; however, most such species belong to other facies. Chiefly because of the occurrence of the southern forms, then, and in the absence of conflicting evidence, the assemblages at hand are considered to be Upper Pleistocene.

TABLE 1. Mollusca from the Upper Pleistocene at Huntington Beach Mesa. Abundance symbols are: R, less than 9; C, 9 to 32; and A, more than 32 specimens in the collection per 1,000 specimens.

PELECYPODA

	Localities: 3655 3656 3657		
<i>Glycymeris subobsoleta</i> (Carpenter)	C	A	A
<i>Modiolus</i> cf. <i>M. capax</i> Conrad	.....	R	R
<i>Modiolus</i> sp.	R	.....	.....
<i>Leptopecten latiauratus</i> (Conrad)	R	R	R
<i>Hinnites giganteus</i> (Gray)	.....	.....	R
<i>Anomia peruviana</i> Orbigny	R	.....	.....
<i>Ostrea lurida</i> Carpenter	.....	R	R
<i>Crassinella branneri</i> (Arnold)	R	C	C
<i>Luciniscia nuttalli</i> (Conrad)	.....	R	.....
<i>Trachycardium quadrigenarium</i> (Conrad)	.....	R	.....
"Cardium" sp.	.....	.....	R
<i>Protothaca staminea</i> (Conrad)	.....	R	R
<i>Tivela stultorum</i> (Mawe)	C	C	R
<i>Petricola parallela</i> Pilsbry & Lowe	.....	.....	R
<i>Tellina bodegensis</i> Hinds	.....	R	R
<i>T. salmonea</i> Carpenter	R	C	A
<i>Macoma secta</i> (Conrad)	.....	R	R
<i>Donax gouldi</i> Dall	A	C	R
<i>Siliqua lucida</i> (Conrad)	.....	R	R
<i>Solen sicarius</i> Gould	.....	.....	R
<i>Spisula planulata</i> (Conrad)	.....	C	C
<i>Schizothaerus nuttalli</i> (Conrad)	.....	R	R
<i>Cryptomya californica</i> (Conrad)	R	R	C
<i>Corbula luteola</i> Carpenter	C	C	C
<i>Zirfaea pilsbryi</i> Lowe	.....	.....	R

SCAPHOPODA

<i>Dentalium neohexagonum</i> Sharp & Pilsbry	R	.....	C
<i>D. pretiosum</i> Sowerby	.....	R	R

GASTROPODA

Megatebennus bimaculatus (Dall)	.....	.....	R
Pupillaria parcipicta (Carpenter)	.....	R	.....
Calliostoma dolarium (Holten)	.....	R	.....
C. gemmulatum Carpenter	.....	R	.....
C. ligatum (Gould)	.....	R	R
C. tricolor Gabb	.....	R	.....
Tegula brunnea (Forbes)	.....	.....	R
T. ligulata (Menke)	.....	R	.....
Halistylus pupoideus (Carpenter)	R	C	C
Tricolia? sp.	.....	.....	R
Aletes? cf. A. squamigerus Carpenter	.....	R	.....
Fartulum occidentale Bartsch	.....	R	.....
Bittium sp.	.....	R	.....
Epitonium cf. E. indianorum (Carpenter)	.....	R	.....
Crepidula coei Berry	.....	R	.....
Neverita reclusiana alta Arnold	.....	R	C
N. reclusiana imperforata (Dall)	.....	.....	R
Acanthina spirata (Blainville)	.....	R	.....
Ocenebra interfossa Carpenter	.....	R	.....
Aesopus chrysalloideus (Carpenter)	.....	R	.....
Mitrella carinata (Hinds)	.....	R	.....
"Nassa" delosi Woodring	.....	R	.....
"Nassa" fossata (Gould)	.....	C	.....
"Nassa" mendica cooperi Forbes	.....	R	.....
Olivella biplicata (Sowerby)	.....	C	R
O. pedroana (Conrad)	.....	C	R
Narona cf. N. cooperi (Gabb)	.....	.....	R
Conus californicus Hinds	.....	R	.....
Acteocina culcitella (Gould)	.....	.....	R

Thus in summary the sediments exposed on Huntington Beach Mesa are essentially contemporaneous with terrace deposits on Newport Mesa and probably with the Palos Verdes sands in the Long Beach and San Pedro regions. The sea was then capable of supporting mollusks that are today restricted to the Panamanian province, presumably because it was warmer, at least at times, than at present. The shallow, sandy, current and wave agitated sea bottom where Huntington Beach Mesa now stands was inhabited by a shallow-water molluscan community similar to recent southern California communities in such habitats but including Panamanian species. The upper surface of Huntington Beach and nearby Mesas is probably a depositional surface, representing the last epicontinental deposits of the sea during the series of events—the "cycle"—that formed the Palos Verdes ter-

race platform and its marine cover. The surface is commonly overlain by thin non-marine sediments that thicken considerably where the former shoreline was bold, as along its landward margin at Palos Verdes Hills. A somewhat similar surface seems to be preserved at an altitude of about 20 feet in the Mission Bay—San Diego Bay district, California (Valentine, in press).

It is a pleasure to acknowledge the aid of Professor W. P. Popenoe and Mrs. Lou Ella Saul, University of California, Los Angeles, in comparing certain specimens, and of Peter U. Rodda, Bureau of Economic Geology, University of Texas, in collecting the fossils. Robert G. Thomas, Engineering Geologist, California State Division of Water Resources, kindly called these deposits to my attention.

DESCRIPTION OF FOSSIL LOCALITIES

UCLA. Locality 3655. Essentially horizontal sands exposed on eastern margin of sand and gravel pit, on west face of ridge north of oil sumps, in N $\frac{1}{2}$ of NE $\frac{1}{4}$, Sec. 34, T. 5 S, R 11 W, Huntington Beach Mesa, Seal Beach quadrangle, Orange County, California. Southwest nose of ridge is now cut away. Uppermost fossiliferous beds; altitude approximately 25 feet. Rodda and Valentine, collectors, spring 1957.

UCLA. Locality 3656. Approximately 12 feet stratigraphically and topographically below UCLA. locality 3655, in a 2-3 foot pebble and cobble conglomerate. Rodda and Valentine, collectors, spring 1957.

UCLA. locality 3657. A 2-foot pebble conglomerate exposed in the northeast corner of the sand and gravel pit described in UCLA. 3655. Evidently represents the same horizon as UCLA. loc. 3656 (exposure is discontinuous). Rodda and Valentine, collectors, spring 1957.

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MOLLUSKS OF THE SALT RIVER, KENTUCKY

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An expedition was made by Dr. W. J. Clench and myself during September, 1958, to collect mollusks in the Kentucky and Salt River systems, Kentucky. We left Ann Arbor, Michigan, September 6, 1958, at the close of a most enjoyable meeting of the American Malacological Union. Traveling south through southern Michigan and Ohio, we collected at several stations in the Great Lakes drainage, and upon arriving in Kentucky on September 7, at two localities on the Licking River. Since the water level was somewhat high, we proceeded to the Kentucky River where several stations were made on the main river and its three forks. This was followed by a week-end trip to Cleveland, Tennessee, to visit Herbert Athearn, an ardent collector of fresh-water mollusks. During this side trip, fine collections were made in the Powell and Sequatchie Rivers, Tennessee, in

the Conasauga River of northwest Georgia and in the Green River, Kentucky.

The Salt River drainage system occupies a roughly oval area in north central Kentucky. Along most of its eastern boundary, it is separated from portions of the Kentucky River system by only a few miles. On the south and west, it is bordered by the Green River system. On the north, tributaries of the Salt River extend north of Louisville, Kentucky. It flows into the Ohio River about 20 miles southwest of Louisville almost precisely on the line of 38° N. Latitude. Two major forks, the Rolling Fork and Beech Fork, and the Salt River proper originate fairly close together in Boyle and Casey Counties, Kentucky. The Rolling Fork, the most southern branch, flows in a northwesterly direction to its confluence with the Salt River proper about nine miles southeast of the Ohio River. The Beech Fork flows north, then west to join the Rolling Fork about twelve miles southeast of the confluence of the latter with the Salt River. The Salt River proper parallels the Beech Fork during its initial northerly flow but continues farther north than the latter, then turns west and flows in this direction to its confluence with the Rolling Fork, then northwesterly to the Ohio River. Very approximately, the drainage area of the Salt River system covers 3000 to 4000 square miles. The system occupies a portion of the "Blue Grass" area of Kentucky, a region of limestone eroded to form a generally rolling surface, and is given over in large part to farming. Also this area supports one of Kentucky's outstanding industries, that of the distillation of fine whiskey. One asks himself on picking up a series of especially large *Quadrula quadrula* (Rafinesque), "Could there be some correlation between the large size of these bivalves and the dumping of distillery wastes into streams of this area?"

We based Salt River collecting operations at Bardstown, Nelson Co., Kentucky, and spent four days making ten stations in this river system. We intended to make several additional stations in the Salt and also the lower Kentucky River working our way east (and home). However, a heavy two-inch rain ended the ideal collecting conditions which had existed for nearly two weeks and our last stations could not be made. Consequently, a thorough report on the mollusks of the Kentucky River must be delayed until further collections can be made there. Our

collections from the Salt River were substantial, however, and are therefore reported upon at this time.

Three stations have been made on the Salt River previously that we know of, although other collectors have undoubtedly visited the area. The known visited localities are those of Clench and Okkelberg in 1927, corresponding to the Clench-Rosewater stations 1934 and 1935 plus one which we did not make: Salt River, 4 miles west of Lawrenceburg, Kentucky. An account of the fresh-water mussels collected by Clench and Okkelberg was published by Clench and van der Schalie (1944). No account was given of the gastropods collected.

Ortmann (1926, p. 187) stated that the Salt River system should be expected to have an Ohioan fauna rather than a Cumberlandian one. Clench and van der Schalie showed this to be true and our 1958 collections only reinforce this view. On the basis of the 1958 collections, four species of mussels may be added to the list of Clench and van der Schalie for the Salt River: *Villosa lienosa* (Conrad); *Carunculina parva* (Barnes); *Truncilla donaciformis* (Lea); *Anodonta grandis* Say. On the other hand, three species mentioned in 1944 were missing from those collected in 1958: *Cyprogenia irrorata* (Lea); *Obovaria subrotunda* (Lea); *Anodonta imbecillis* Say.

Goodrich (1939, p. 2 and 1940, p. 13) stated that forms not separable from *Pleurocera acutum* Rafinesque² occur in tributaries of the Cumberland and Duck Rivers, Tennessee. This is, apparently, also true of the Beech Fork and the Salt River proper stations (1934, -36, -40, -41) as forms representing and, at present, indistinguishable from *P. acutum* were also found there.

To my knowledge, there is no previous published record of *Pleurocera canaliculatum* (Say) from the Salt River system. We found it, along with *Lithasia obovata* (Say) at station 1939, a locality with a distinctly large river ecology. The *Lithasia* had remarkably complete, pointed spires for this species. The other locality recorded for *P. canaliculatum*, station 1934, yielded only a few dead specimens. For this reason, it is questionable whether the species lives there or was washed down from an area above a partially demolished rock dam where the Beech

² Morrison (1954, pp. 359-364) discusses the taxonomy of the subfamily Pleurocerinae in North America and gives reasons for use of different nomenclature than is employed here; also see Hemming (1951, pp. 6-17).

Fork runs wide and deep. Attempts to collect above the dam failed because of hazardous conditions due to steep and slippery banks at this locality.

I wish to acknowledge the aid of my associates, Richard I. Johnson and Arthur H. Clarke, Jr., in the department of mollusks, Museum of Comparative Zoölogy, in checking identifications of certain mussels. H. B. Herrington identified *Sphaerium striatinum* (Lamarck). Thanks are given to Dr. W. J. Clench for checking the identification of *Physa* and *Campeloma*, for sharing with me his broad knowledge of fresh-water mollusk collecting and for the many valuable experiences we shared in the field. Financial aid for this trip was made possible by the Friends of The Department Of Mollusks Fund, Museum of Comparative Zoölogy.

The following is a list of the collecting stations visited in the Salt River system, Kentucky, in September, 1958. Preceding each station and its description is the station number. This number is repeated in the list of fresh-water mollusks denoting where each species was collected.

1932. Rolling Fork, Salt River, 7 miles southwest of Lebanon, Marion Co., Ky. (Ky. Route 55); September 16, 1958. Ledge rock with gravel-rock overlay; water clear, quite warm; gastropods and bivalves rare, the latter often lying out on substrate, the former crawling on rocks and gravel.

1933. Cartwright Creek, 13 miles southeast of Bardstown, Washington Co., Ky. (U.S. Rt. 150); September 16, 1958. Ledge rock; water very shallow; no bivalves found; *Goniobasis* abundant in pools and on bridge pillars.

1934. Beech Fork, Salt River, 1 mile southwest of Bardstown, Nelson Co., Ky. (U.S. Rt. 31E); September 17, 1958. Gravel, some rock; water low, dammed above bridge; a large sewer pipe entering just below dam; dead bivalves and snails abundant; *Physa* abundant on sewer sludge.

1935. Rolling Fork, Salt River, 1 mile south of New Haven, Nelson Co., Ky. (U.S. Rt. 31E); September 17, 1958. Rocky gravel; water clear in spite of heavy rain, flowing over rapids and shoals; bivalves abundant, pleurocerids fairly so.

1936. Beech Fork, Salt River, about 3 miles south of Bardstown, Nelson Co., Ky. (Ky. Rt. 49); September 18, 1958. Ledge, gravel, stones, sand and some silt; dead bivalves abundant, apparently washed out of substrate by recent freshets; pleurocerids in very great abundance on mud and rocks; viviparids in sand; dead sphaeriids in great abundance on banks.

1937. Rolling Fork, Salt River, Raywick, Marion Co., Ky. (Ky. Rt. 527); September 18, 1958. Gravel bars with some rock; bivalves abundant; *Goniobasis* abundant in drying puddles.

1938. Wilson Creek, about 2 miles northwest of Boston, Nelson Co., Ky. (Ky. Rt. 61); September 19, 1958. Ledge rock; water clear, fairly warm, silt on ledges; no bivalves collected; *Physa* and *Lymnaea* rare; *Goniobasis* very common.

1939. Rolling Fork, Salt River, 1 mile southwest of Lebanon Junction, Bullitt Co., Ky. (Ky. Rt. 434); September 19, 1958. Steep, muddy banks, channel narrow and deep; water roily, rather fast flow; bivalves probably present but impossible to collect; *Lithasia obovata* and *Pleurocera canaliculatum* not uncommon on banks.

1940. Salt River, 3 miles southeast of Mt. Washington, Bullitt Co., Ky. (U.S. Rts. 150 and 31E); September 19, 1958. Gravel-rock bottom, sand and silt; water fairly clear; bivalves very abundant, especially in backwater areas; pleurocerids rather rare.

1941. Salt River, 5 miles west of Taylorsville, Spencer Co., Ky. (gravel road); September 19, 1958. Gravel-rock bar, shoals extending for several hundred feet on either side of bridge; water somewhat murky, a few rapids; large bivalves very abundant above rapids; pleurocerids common on rocks and mud at margins, *Campeoloma* very abundant in sandy mud.

MOLLUSKS OF THE SALT RIVER SYSTEM

Station No.:	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941
Viviparidae										
<i>Campeoloma ponderosa</i> (Say)	.....	.....	x	.....	x	x	.....	.....	x	x
<i>Lioplax sulculosa</i> (Menke)	.....	.....	x	.....	x	.....	.....	.....	.....	x
Pleuroceridae										
<i>Pleurocera acutum</i> Raf.	.....	.....	x	.....	x	.....	.....	.....	x	x
<i>P. canaliculatum</i> (Say)	.....	.....	x	.....	.....	.....	.....	x	.....	.....
<i>Goniobasis semicarinata</i> (Say)	x	x	x	x	x	x	x	.....	x	x
<i>Lithasia obovata</i> (Say)	.....	.....	.....	.....	.....	.....	.....	x	.....	.....
Physidae										
<i>Physa integra</i> Haldeman	.....	.....	x	.....	x	.....	x	.....	.....	.....
Lymnaeidae										
<i>Lymnaea humilis</i> Say	.....	.....	.....	.....	.....	.....	x	.....	.....	.....
<i>L. columella</i> Say	.....	.....	.....	.....	.....	.....	x	.....	.....	.....
Unionidae										
<i>Fusconaia flava</i> (Raf.)	.....	.....	.....	.....	x	x	.....	.....	.....	x
<i>Crenodonta gigantea</i> (Barnes)	.....	.....	.....	x	x	.....	.....	.....	.....	x
<i>C. costata</i> (Raf.)	.....	.....	.....	x	x	x	.....	.....	x	x

<i>Quadrula pustulosa</i> (Lea)	.....	x	.....	.....	x
<i>Q. quadrula</i> (Raf.)	.....	x	x	x	x
<i>Tritogonia verrucosa</i> (Raf.)	.....	x	.....	x	x
<i>Elliptio dilatatus</i> (Raf.)	.....	x	x	x	x
<i>Lasmigona costata</i> (Raf.)	.....	x	x	.....	x
<i>L. complanata</i> (Barnes)	.....	x	x	.....	x
<i>Anodonta grandis</i> Say	.....	x	x	x	x
<i>Alasmidonta calceolus</i> (Lea)	x	.....	.....	.....	.....
<i>Strophitus rugosus</i> (Swainson)	.....	.....	x	.....	x
<i>Ptychobranthus fasciolaris</i> (Raf.)	.....	x	x	x	.....
<i>Obliquaria reflexa</i> Raf.	.....	x	.....	.....	.....
<i>Actinonaias carinata</i> (Barnes)	x	.....	x	x	x
<i>Leptodea fragilis</i> (Raf.)	x	x	x	x	x
<i>Proptera alata</i> (Say)	.....	x	x	x	x
<i>Carunculina parva</i> (Barnes)	.....	.....	.....	.....	x
<i>Villosa lienosa</i> (Conrad)	.....	.....	x	.....	.....
<i>Lampsilis anodontoides</i> (Lea)	.....	x	x	x	x
<i>L. radiata siliquoidea</i> (Barnes) ³	.....	x	x	.....	x
<i>L. ovata ventricosa</i> (Barnes)	x	x	x	x	x
<i>Truncilla donaciformis</i> (Lea)	.....	.....	x	.....	.....
<i>T. truncata</i> Raf.	.....	.....	x	.....	x
<i>Dysnomia triquetra</i> (Raf.)	x
Sphaeriidae					
<i>Sphaerium striatinum</i> (Lamarck)	x	x

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³ Clarke (1958, pp. 15, 16) has shown that reproductive isolation is lacking between *L. radiata* (Gmelin) and *L. siliquoidea* (Barnes) and that the latter may be considered a subspecies of the former.

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ON THE GREEN LAND MOLLUSK FROM NEW GUINEA

By J. B. HENRARD

Oegstgeest, The Netherlands

Some time ago, I received a letter from a fellow conchologist, who called to my attention an article by Dr. Clench, in *Breviora*, 1957, no. 76. In this paper, a curious green land-shell was described; it was said to be from New Guinea, but without exact locality or collector. The species was received from Mr. Poling, who bought it from a dealer, and presented it to the Museum of Comparative Zoölogy, at Harvard University. My American friend, who knew that I had brought together a very large collection of land-snails during the years I stayed in Dutch New Guinea, suggested that this green snail probably would be represented in my cabinet. Indeed, since I had received a copy of the publication from him and had read Dr. Clench's paper carefully, I recognized the shell at once, and had it from several, widely separated localities in northwest New Guinea. The shell was considered by Dr. Clench as a member of the subfamily Chloritinae, and a new subgenus *Verdichloritis* was created for it. The photo in the article, enlarged 4 times, is rather bad. The name of the species finally was given as *Eustomopsis (Verdichloritis) polingi* Clench.

All the specimens in my collection agree so completely, in dimensions and in all other characters, with the description of Dr. Clench, that I do not hesitate to accept them as belonging to his species. However, I have a different opinion in regard to the correct genus to accept for this species, because all my examples, which are adult or were taken alive, have a very striking character. Just behind the reflexed peristome, the body whorl has a very curious gibbous crest, which is separated from the peristome by a shallow sulcus, that runs downwards to the open umbilicus. This character does not occur in the genus *Chloritis*, but is present in all species of the subgenus *Cristigibba* Tapparone-Canefri, which was established for those species of the genus *Planispira* that have such a gibbous crest. This sub-

genus was accepted as a section by Thiele, Handb., p. 681. This character is absent from *Chloritis*, as may be seen by comparison of Thiele's descriptions of the two genera. Shells with hairy periostraca occur in both.

I wish to give here all the data on the 1949 discovery of this species.

Mollusk collecting in the tropical regions is much more difficult than elsewhere, because the collector is hampered by the very dense vegetation of the primeval forest. The presence of snails often is indicated by dead and worn shells among rotten, wet leaves at the bases of trees and shrubs. In somewhat more open places, two species of *Planospira* are rather common. Both, although variable in banding and in color of peristome, are easily recognizable. These species are: *Planispira tortilabia* (Lesson) and *P. corniculum* (Hombr. & Jacq.). Both belong to the subgenus *Cristigibba* also. I collected plenty of them; their beautiful varieties are still insufficiently described. During my holidays, I was a guest of some friends, who had a bivouac near Klamesien, a locality situated on the western part of the large peninsula called "De Vogelkop" (i.e., Bird's Head). At Klamesien, I could make many exploring trips in all directions; this locality proved to be very rich; and a fine collection was brought together. One day, under very dense vegetation, I found a dead but perfect shell of a dull grayish color, but with the same gibbous crest as in other members of the *Cristigibba* group. It was thus a species of the genus *Planispira*, but was quite unknown to me, being smaller than the two species mentioned above. Moreover this specimen was peculiar because, within the mouth on the parietal area, there was a green spot. Further search yielded more, similar specimens and also a much damaged one, which was, however, provided with a green periostracum and was still somewhat hairy. Fortunately this damaged shell had the last part of the body whorl with a quite intact peristome, and proved to be conspecific with the first examples, which were totally denuded shells. This green species is arboreal, and detection of living ones among the dense vegetation of nearly the same color was very difficult. The locality was combed as thoroughly as possible but only two living specimens were obtained. The greenest *Planispira* would be a suitable name for this unique

species. Understandably, when other localities were visited, my friends and I tried to locate this species, and we did find them, but never in sufficient quantities. My friend J. Kanter handed me two fine specimens, found by him near Klamaloe, and Mr. H. C. Kavelaars, a very good shell-hunter, gave me a very fine one found between the Kлага- and Klasafet River. All these are from localities north of the Gulf of McClure. We were, however, fortunate enough to detect this species also south of the Gulf, when we had a beautiful and very profitable trip to the large island of Salawati. Here we went further on the Waiboe River, a long way, to our bivouac near Waileh in the northern part of the island. There, on the so-called Waiboe Ridge, a calcareous area, very fine mollusks could be procured, and once more we obtained a few living specimens. Our conclusion was that this species, which occurred in so widely separated localities, is not actually very rare, but appears to be, because it is so difficult to obtain. As a member of the genus *Planispira*, its name now becomes: *P. (Cristigibba) polingi* (Clench).

In regard to the other green shells, mentioned in Dr. Clench's paper, there are fundamental differences between this *Planispira* and such genera as *Liguus*, *Amphidromus*, and all the other shells mentioned by him. In all those shells, the coloring matter is situated in the calcareous layer of the whorls, while in this green *Planispira* only the periostracum and its hairs are green. To the species, in which totally green whorls occur, I may add the very beautiful *Amphidromus ventrosulus* Moellendorff, which, according to Fischer and Dautzenberg, is a subspecies of *A. smithi* Fulton. In this shell, the aperture also is green-colored.

STUDIES ON MOLLUSK POPULATIONS: 4

By R. STOHLER

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T. S. Oldroyd (1918) described a new variety of *Olivella biplicata* (Sowerby) and named it *angelena*. It was distinguished from the typical species as "being more delicate and slender." He also states: "Sowerby's type came from Monterey and does not occur near San Pedro living, but is found fossil there in the Pliocene and lower Pleistocene. Variety *angelena* is found fossil in both the upper and lower San Pedro beds of the Pleistocene."

From the text of the note the reader is led to assume that *O. b. angelena* is based on a fossil shell, but the holotype in the Oldroyd collection at Stanford University is a fresh shell from Los Angeles.

In 1921 the same author described two additional varieties of *Olivella biplicata*. The first of these two varieties he named *fucana* and stated that it was broader across the middle and lower part of the aperture than var. *angelena*. In addition to the type locality "Straits of Fuca, near Cape Flattery" where the variety was collected alive he also lists the Pliocene at San Pedro. The second variety, named *parva*, had been collected at Point Abreojos in Lower California by Henry Hemphill and was described as being "nearest *angelena*, but much smaller, a little broader in proportion; . . .; found in the upper Pleistocene at San Pedro." With the descriptions of these two new varieties, Oldroyd figured presumably the type specimens of all three varieties as well as of a shell he called "typical" (obviously meaning a typical *O. biplicata*).

Mrs. Oldroyd (1927) reprinted the descriptions almost verbatim, except that the first variety was then called *angelina*, that in the description the type locality was given as Los Angeles County (not included in the original description) and that nothing was said about the fact that T. S. Oldroyd (l.c.) made no reference whatever to a living specimen. Furthermore, the range of the variety was given as from San Pedro to San Diego. On her plate 26, Mrs. Oldroyd illustrated the varieties; however, the figures evoke the impression that they have been badly retouched and close inspection indicates the possibility that the photographs of the shells were cut out and pasted up for reproduction.

Through the generous cooperation of Dr. A. Myra Keen, for which I wish to express my gratitude, I was permitted to measure the holotype of each variety in the Oldroyd collection at Stanford University; at the same time all other designated specimens in the type lots of the same collection were measured. To insure greater accuracy, all specimens were measured again after approximately one year had elapsed. The results are given in Table 1.

D. S. and E. W. Gifford (1944) gave a number of measure-

ments, made on a large series of shells collected in various localities. They used the length-width index as an indicator of the relative obesity of shells. This index is obtained by dividing the width of the shell by its length and multiplying the result with 100. The Giffords showed that the populations they studied fully overlapped, as far as the indices were concerned, all Oldroyd's varieties, although for the indices of the latter they limited their calculations to the measurements of the type figures in the NAUTILUS (1921) and the measurements of the shells as recorded by Mr. Oldroyd.

The problem of relative obesity and absolute shell sizes attracted my attention. *Olivella biplicata*, being a rather common shell and easily collected throughout the year, at least in certain localities, seemed to be an especially favorable object for a more generalized study. A number of observations concerning the natural history of this species were made in the course of this particular inquiry and some of them, which may have a bearing on some of the aspects involved in the questions revolving around the validity of Oldroyd's varieties, will be included in this report.

To insure accuracy as well as speed in measuring the shells (a total of over 6200 was involved) a modified sliding caliper was used to construct an imaginary rectangle around the shell. Figure 1 illustrates the manner in which the width of the shell was measured and Figure 2 shows the measuring of the length of the shell. The dial allows direct reading of tenths of millimeters, while the bar shows the centimeters. By adding the cross bar, accurately ground to form a snug gliding fit for the legs of the caliper, truly comparable measurements on all shells could be made with ease. The two ends of the canal of the shell were used to form a firm base, as shown in the figures; the width was obtained in all cases by gently rotating the shell between the legs of the caliper until the greatest width was found. That the method was reliable is borne out by the fact that no differences were obtained in the measurements of the same shells in the Stanford collection made over a year apart.

Table 2 gives the results obtained from 7 lots, collected in California from Drakes Estero, Marine County (appr. 38° N) to La Jolla, San Diego County (appr. 33° N). The accompanying

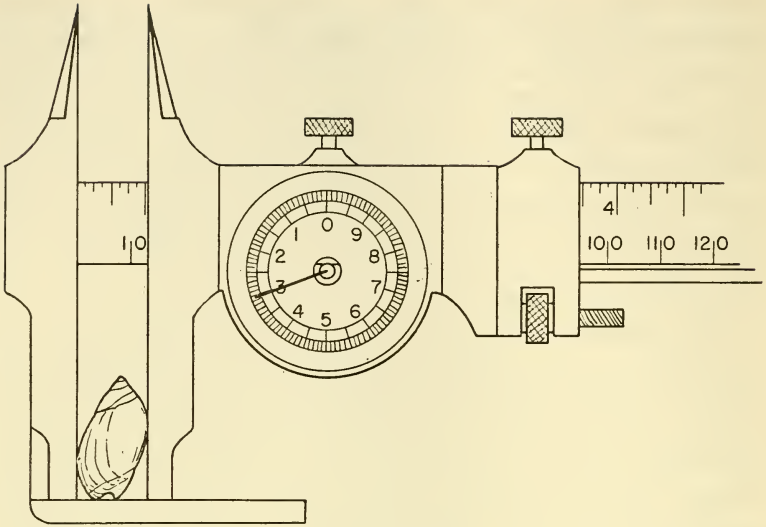


Figure 1: Sliding calipers, modified. The base of the canal of the shell is gently rotated until the largest diameter is ascertained; the dial reads in tenths of millimeters.

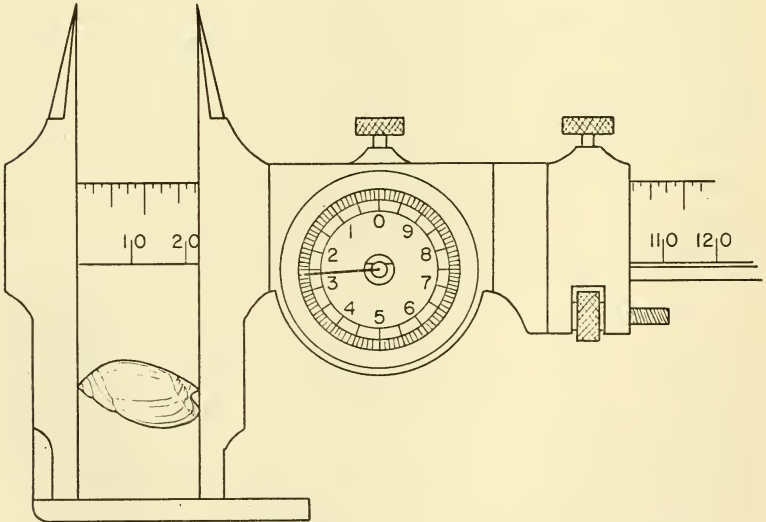


Figure 2: Sliding calipers, modified. To ascertain the greatest height of the shell, the base of the canal is set firmly upon the moving leg of the instrument and moved until the apex just touches the stationary leg.



Figure 3: Outline map of California showing the six localities in which *Olivella biplicata* (Sowerby) were collected for this study. DE = Drakes Estero; DR = Duxbury Reef; PP = Pillar Point; MH = Monterey Harbor; GP = Government Point; LJ = La Jolla.

map (Fig. 3) shows the 6 localities at which the collections were made. In Table 3, the figures obtained from 11 separate groups collected in one locality at more or less regular intervals are reproduced. Additional lots have been collected, measured and their indices computed for the Duxbury Reef area (near Bolinas, Marin County, California) but the figures are not included here as it was considered unnecessary to add more of the same results. In actuality, the study at Duxbury Reef covered collections over a period of 18 months with semi-monthly visits, meteorological conditions permitting; the total included 4258 individuals, and

Table 1: "Varieties" of *Olivella biplicata* (Sowerby)
in the Oldroyd Collection at Stanford University.

		<i>O. b.</i> <i>angelana</i> Oldroyd	<i>O. b.</i> <i>fucana</i> Oldroyd	<i>O. b.</i> <i>parva</i> Oldroyd	<i>O. b.</i> <i>lapillus</i> Vanatta
holotype	length	278	275	169	
	width	137.5	147	95	
	index	49.46	53.45	56.21	
paratype	length	300			
	width	150			
	index	50.00			
number of specimens		51	18	46	14
largest specimen	length	300	293	169	310
	width	150	163	95	155
	index	50.00	55.63	56.21	50.00
smallest specimen	length	118	228	69	134
	width	68	115	40	81
	index	57.63	50.44	57.97	60.45
slenderest specimen	length	262	238	88	231
	width	124	112	45	110
	index	47.33	47.06	51.14	47.62
most obese specimen	length	124	241	115	134
	width	73	141	71	81
	index	58.87	58.51	61.74	60.45
average	length	201.31	253.22	108.15	215.43
	width	110.52	130.55	60.93	113.14
	index	54.90	51.44	56.36	52.52

among them 49 mating pairs (M. P.).

In all three tables the same terms are used. Measurements are in units of one-tenth millimeters; thus the holotype of *O. biplicata angelana* Oldroyd measures 278 units or 27.8 mm. in length and 137½ units or 13.75 mm. in greatest width. From each lot, after all measurements were completed, the figures for the largest (i.e., longest) and smallest (i.e., shortest) specimen were selected; in the same manner the slenderest or least wide and the most obese or widest specimen was singled out. Finally the purely arithmetical averages were computed. The information in

Table 2: *Olivella biplicata* populations from various California localities.

	Dakes Estero	Duxbury Reef	Pillar Point	Monterey Harbor	Government Point	La Jolla I	La Jolla II
number of specimens	540	2441	450	1044	704	790	318
largest specimen { length width index	244 140 57.38	312 165 52.88	300 171 57.00	274 163 59.49	270 154 57.04	253 140 55.34	213 118 55.39
smallest specimen { length width index	46 25 54.35	105 62 59.02	165 107 64.85	39 21 53.85	85 51 60.00	78 46 58.97	67 36 53.73
slenderest specimen { length width index	204 106 51.96	268 123 45.90	260 134 51.54	242 123 50.92	139 72 51.80	213 107 50.23	178 89 50.00
most obese specimen { length width index	185 122 65.94	233 151 64.81	239 158 66.11	101 69 68.32	173 119 68.79	104 69 66.35	155 97 62.58
average specimen { length width index	192.32 113.20 58.91	219.17 123.06 56.26	226.02 134.91 59.81	146.77 87.66 59.83	192.92 114.90 59.72	150.65 85.39 56.77	150.40 84.77 56.37

the tables is considered sufficient for the present study.

Of the three Oldroyd varieties, as will be recalled, *angelena* was supposed to be slenderer and *fucana* broader or more obese than "typical" *Olivella biplicata*. For reasons to be discussed below, these two varieties will not be compared here with "typical" shells. Table 1 shows, by the obesity index, that *O. b. fucana* is, indeed, more obese than *O. b. angelena*, at least if only the holotype is considered. As may be noted, however, the "slender" variety includes at least one specimen that is more obese than the most obese of the so-called obese variety; furthermore, as appears from the averages, the "slender" variety is actually more

obese than the "obese" variety. This alone should be sufficient to show the invalidity of the criterion used by Oldroyd to distinguish the two varieties.

In regard to *O. biplicata parva* Oldroyd, as may be pointed out, we have, in a fairly good sample, a shell of a small average; as I have been unable to obtain large, unselected population samples from Punta Abreojos I am not prepared to make, at this time, any positive statements. However, I believe that the table gives some clues, when taken together with the information contained in the other two tables, as to the nature of this particular lot (see the discussion further below).

A careful comparison of the various figures in Table 2 shows that, from sample to sample, there is but little variation in the data, a fact which should not be surprising, although it might be expected that in the extremes of the distributional range of a species having such a large geographical range, differences might be observed. This still might hold true for *O. biplicata* if significant population samples from the true extremes of the range were available; Table 2, however, includes only a somewhat southern quarter of the entire range, it being the area from 33° to 38° north latitude, while, according to Keen (1937) the species may be found from 25° to 49° N.

(To be continued)

THE CHARLES M. WHEATLEY COLLECTIONS

BY RICHARD I. JOHNSON

Charles Moore Wheatley was born in 1822, and in 1842, at the age of 20, he published privately a "Catalogue of the shells of the United States, with their localities." A second edition appeared in 1845. His only other paper on conchology was published in 1865 in the *American Journal of Conchology* 1, pp. 65-67: "Revision of M. Petit's Catalogue of the Genus *Monodonta*." He was an engineer by profession, also interested in geology, and made some important fossil discoveries in Pennsylvania. Wheatley died on May 6, 1882.

In his article of 1862 on "The history of conchology in the United States," G. W. Tryon mentions that Wheatley's collection had become the property of Union College, Schenectady, New York. By this date, Isaac Lea had described 19 species which he mentioned as being "In the cabinet of C. M. Wheatley." This

collection after suffering from neglect was transferred from Union College to the Schenectady Museum Association during the 1930's where it remained until 1959, essentially, in the condition in which it was packed for transfer. The author was invited by the director, Mr. Donald S. Smith, to remove to the Museum of Comparative Zoology, Cambridge, Massachusetts, any specimens that were, in his opinion, of scientific interest. In this effort, Mr. Smith and Mr. Russell Carter, science curator, offered every assistance and courtesy.

Apparently about 1860, Wheatley decided to specialize in freshwater shells. This is attested to by his advertisements for exchanges in the American Journal of Conchology. He therefore left only a token series of freshwater lots in this collection. Of the species specifically mentioned by Lea as being in the collection, only *Anodonta schröteriana* and *Unio micans* were found.

In a published, though undated, sales catalogue issued, presumably, after Wheatley's death, a John A. Tydner of Philadelphia offered the freshwater collection for sale. He divided the collection into two similar series which were offered for sale at \$2000 and \$1750. From the information supplied by Dr. R. T. Abbott, apparently both of these collections are now in the Academy of Natural Sciences of Philadelphia. One is on "permanent deposit" from the University of Pennsylvania and the other was formerly the property of E. D. Cope.

Now in the collection of the Museum of Comparative Zoology are some of the lots mentioned in the "Catalogue" of 1842, though not many. There are 30 lots of Jamaican land snails from C. B. Adams. (The main C. B. Adams collection is in the Museum of Comparative Zoology). Included are 62 type lots from the collection of Hugh Cuming of species presumably selected by him and described by Pfeiffer, Broderip, Sowerby, Jonas, Beck, and Reeve. Most of these species are Philippine land snails. (For a discussion of the Cuming types see: Clench, W. J., 1945, "Some Notes on the Life and Explorations of Hugh Cuming," Occ. Pap. Moll., Harvard Univ. 1, no. 3.)

From Bishop S. Elliott are 3 species of Unionidae described by Isaac Lea and 2 species of Cuban land shells from Elliott described by Poey. There are 6 more unionid types described by Lea, 3 from W. A. Haines and 3 from other sources. Already mentioned are the 2 type lots of the species from Wheatley

which Lea described. Finally, there are 3 type lots of land shells described by A. A. Gould.

In all, the first Wheatley collection contained 108 type lots in addition to which are almost 300 other lots with sufficient data or historic interest to be worthy of retention.

TWENTY-FIFTH ANNUAL MEETING OF THE AMERICAN MALACOLOGICAL UNION

The AMU. returned to its birthplace for this silver anniversary meeting, for the Academy of Natural Sciences was where the organization meeting was held in 1931. (Annual meetings were suspended during World War II). Of those present at the first meeting, the following were on hand when, on Tuesday, June 30, 1959, the twenty-fifth annual meeting was called to order: H. B. Baker, Joshua L. Baily, Jr., William J. Clench, Harald A. Rehder and Fred Tobleman.

The scene was Haverford College on the western outskirts of Philadelphia, and there the members of the Philadelphia Shell Club vied with one another to make comfortable the largest assemblage in AMU. history. When the meeting was over, 133 had signed the register, and agreement was unanimous that it had been an enjoyable and instructive four days.

Split sessions were held for the first time in AMU. meetings, and in two halls President R. Tucker Abbott and Vice-president Katherine Van Winkle Palmer presided as dual audiences heard the following papers and talks:

"In search of *Neopilina*." Arthur H. Clarke, Jr.; "Sanibel Island shell fair," Lulu B. Siekman; "Origin of the Land and Fresh-water mollusks of the Bahamas," William J. Clench; "Small beginnings," Adlai B. Wheel, Sr.; "Classification in the Olividae," John Q. Burch; "Early Philadelphia conchologists," John D. Parker; "The strange phenomenon of autotomy in *Tremoctopus*," Richard W. Foster; "Mechanics of a shell club," Robert J. Wagner; "Some conchological miscellanies," Joshua L. Baily, Jr.; "Expedition to the Philippines," John du Pont; "Some techniques for anatomical work," Ruth D. Turner; "Shell collecting around the world," Joseph J. Kuchar; "Marine zoogeography, with special reference to the South Pacific area," Harald A. Rehder; "Our experiences photographing mollusks," Mrs. Theophil Kuczynski; "The egg mass and gross embryology

of *Pleurocera canaliculatum*," Joseph Rosewater; "Mollusks, a sound color movie"; "Unearthing Gould's types," Richard I. Johnson; "Observations on *Murex stainforthi* and *M. monodon*," Virginia Orr; "Chromosomes of *Pomatiopsis* and *Oncomelania*," John B. Burch; "Quantitative sampling of aquatic mollusks," Charles B. Wurtz; "The Coosa revisited," Paul F. Basch; "The Mollusca of Bernard Palissy, 1580," Aurele LaRocque; "Xanthonychidae (Pulmonata)," H. Burrington Baker; "Subspeciation in *Triodopsis*," Joseph Vagvolgyi; "The mollusk fauna of Bahamian mangroves," Robert Robertson; "Collecting at Broome, Western Australia," Virginia Orr.

At a brief business meeting on Thursday morning, the following were elected officers for 1959-60:

President, Katherine Van Winkle Palmer; Vice-president, Thomas E. Pulley; 2nd Vice-president, Chairman-incumbent, AMU-Pacific Division; Secretary-treasurer, Margaret C. Teskey; Publications Editor, George M. Moore; Councillors-at-Large, Alger P. Blaine, John E. Fitch, Richard Foster, Alan Solem. It was announced that the council had accepted the invitation of McGill University Museum to hold the 1960 meeting in Montreal, Canada, in mid-August, and that the names of Dr. Julia Gardner and Dr. Ralph Arnold had been added to the list of Honorary Life Members, and that Dr. Paul Bartsch had been elevated to Honorary Life President.

Other features of the meeting were the informal amateur symposium of Tuesday evening, a showing of slides and movies of former meetings following dinner on Wednesday, and an especially enjoyable social session which occupied all of Thursday afternoon and evening.

Starting with a bus ride to the Academy of Natural Sciences where exceptional exhibits of shells, shell products and books arranged by members of the Philadelphia Shell Club awaited inspection, guests were given a guided tour of the Department of Mollusks, treated to a delightful tea by Mrs. Ruth Ostheimer and Miss Anne Harbison, later were entertained by General Frank and Dr. Jeanne Schwengel at the cocktail hour which brought memories of many other such occasions to those who have enjoyed the hospitality of the Schwengels in the past.

The annual dinner at 8:00 was held in the ANSP. auditorium and made memorable by excellent steak, an inspirational talk by Dr. Kenneth W. Prescott, Managing Director of the Museum,

and by individual place favors of pearl-bearing oysters (real oysters, real pearls!) each tidily preserved in its own take-home jar.

Following breakfast on Friday morning two chartered buses transported those making the field trip to Cape May, New Jersey, where a tour of the Snow clam canning factory, picnic lunch on the Point, an afternoon devoted to collecting land and marine shells and finally the long ride back to Haverford rang down the curtain on the twenty-fifth annual meeting.—MARGARET C. TESKEY.

NOTES AND NEWS

ZACHRYZIA AURICOMA (Férussac) in Miami, Florida.—Recently Dr. H. A. Denmark, entomologist of the State Plant Board of Florida, sent a series of land and freshwater mollusks from Florida for routine determination. In this sending, there were two species of *Zachryzia*: *Z. provisoria* (Pfr.) and *Z. auricoma* (Férussac). The record of *Z. provisoria* from Miami was reported upon by Clarke (Naut. 70: 142, 1957). So far as I can determine, this is the first record of *Z. auricoma* outside of Cuba. A subspecies, *Z. a. havanensis* Pilsbry, has been reported from Quinta, Merida, Yucatan and the city of Panama, Panama, by Bequaert and Clench (Publ. no. 457, Carnegie Inst. of Washington, p. 64, 1936).—W. J. CLENCH.

GREEN SHELLS.—On an earlier page, J. B. Henrard states that the calcareous layer in *Liguus* shells is green. In those before me, it actually is whitish, but is so thin and translucent that the green in the periostracum shows through and often is visible from inside the aperture.—H. B. B.

INTERTIDAL STRANDING of *Clione limacina* in Massachusetts.—On May 5, 1959, 29 living individuals of the gymnosomatous pteropod, *Clione limacina* (Phipps, 1774), were collected from pools in sand and mud and from *Zostera* beds where they were stranded by the receding tide on the Lynn Harbor side of Little Nahant, Essex Co., Massachusetts. To my knowledge, a published record of this species occurring inshore on this coast has been made only once in the past 91 years. Wood (1869, Proc. Portland Soc. Nat. Hist., 1, Pt. 2: 185-188) noted its presence in

numbers in Portland Harbor from April 6 to May 7, 1868. Previous to this DeKay (1843, Zool. of N. Y., Pt. 5, Mollusca, p. 6) reported it from New York bays in April, 1883. Dr. J. H. Welsh, Biological Laboratories, Harvard University, stated (personal communication) that he has collected this species at Nahant on at least two occasions between 1938 and 1945, but has not seen it again until this year. Possibly the species does occur inshore more often than is generally supposed. However, undoubtedly notice would have been made of these animals if this occurrence were frequent because of the easily visible bright red coloration of the organs which are outstanding in their delicately opaque bodies. Probably onshore winds, ocean currents, and spring tides during April and May have much to do with the sporadic appearance of this pelagic species.

The usual habitat of *Clione limacina* is in surface waters of the open ocean in boreal portions of the Atlantic and subarctic Atlantic and Pacific oceans. In the western Atlantic, it is found as far south as the latitude of Cape Hatteras (see J. J. Tesch, 1950, Dana-Report No. 36; also, references have been made to *Clione limacina* on the English coast by J. E. Morton, 1958, J. Mar. Biol. Ass. U.K., 37: 287-297 and M. V. Lebour, 1931, *ibid.*, 17: 785-795). The only other report of the inshore occurrence of a gymnosomatous pteropod species in New England is that of Danforth (1907, Proc. Bost. Soc. Nat. Hist., 34: (1): 1-19) who described *Paedoclione doliiformis* which appeared in Casco Bay, Maine, during August and September, 1902.—JOSEPH ROSEWATER, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts.

MELONGENA EGG CASES.—Captive animals of *Melongena corona* (Cf. Naut. 73:11-13) produced egg cases again, beginning on June 23, 1959, when 9 cases, one with 112 eggs, were placed on the side of the aquarium.—RUTH D. TURNER.

PUBLICATIONS RECEIVED

NEW LAND MOLLUSCA from the Admiralty and Bismarck Islands. By William J. Clench. Amer. Mus. Novit, no. 1863: 6 pp., 7 figs. 1957.—*Pseudocyclotus coultasi*, *P. incendium*, *Dendrotrochus coultasi*, *Nesonanina unidentata* and *Sulcobasis (Goldielix) fasciata* (from Manus I.) are proposed as new.—H. B. B.

THE LAND AND FRESHWATER MOLLUSCA. By William J. Clench. From "The Nat. Hist. of Rennell I., British Solomon Is." vol. 2:155-202, 3 figs., pls. 16-19. 1958.—*Palaeohelicina* (s.s.) *mayri*, *Taheitia whitneyi*, *Setaepoma mayri*, *Nesopoma*, genus of Assimineidae with *N. eyerdami* (type) & *N. galathea*, *Omphalotropis nebulosa guppyi*, *O. quirosi*, *Charopa hoeyeri*, *C. insularis*, *Quirosella*, genus of "Ariophantidae," with *Q. coultasi* (type), *Q. wolffi* & *Q. knudensi*, *Trochomorpha mcleani*, *Crystallopsis* (s.s.) *crystallina*, subgenus *Cristovala* (type *Helix tricolor* Pfr.), with *C. (C.) rennellensis*, (vague genitalia) *Eustomopsis bellonensis*, and *E. renschi* are new. The radular figs. of *Quirosella* (like *Nesonanina*) apparently confuse the cusps on the laterals with their basal thickenings.—H. B. B.

SOBRE "TURBONILLA (PYRGISCUS) DISPAR" Pilsbry, 1897 (Gastropoda, Pyramidellidae). By H. de Souza Lopes. Sobre un novo gastrópodo brasileiro do genero "*Solariella*" Wood, 1842 (Trochidae). By Lopes & Paulo de Sá Cardoso. Rev. Brasil. Biol. 18 (1):17-21, 11 figs., and 59-64, 3 figs. 1958.—*Solariella carvalhoi* is new, from 57 meters depth, S. Paulo.—H. B. B.

NOTE SUR DREPANOTREMA ANATINUM ET TAPHIUS PEREGRINUS (Pulmonata, Planorbidae). By W. Lobato Paraense & Newton Deslandes. J. de Conch. 118:152-162, 22 figs. 1958.—As usual with the authors, the genitalia, radulae and shells are figured exquisitely.—H. B. B.

SYSTEM AND PHYLOGENY OF PLANORBIDAE (Gastropoda Pulmonata). By Ja. I. Starabogatov. Bull. Moskov. O-va. Isp. Prirod. (Soc. Investigators of Nature), Biol. 63 (6):37-53, 4 figs. & phylogenetic scheme. 1958.—In the family Planorbidae are included the typical subfamily (tribes sens. str. & Segmentinini), Planorbulinae and Biomphalariinae (tribes s. s. & Acrorbini, new). In Camptoceratidae (= Bulinidae) are recognized Camptoceratinae (= Coretinae + Helisomatinae), Plesiophysinae, Bulininae and Physastrinae, new (= Miratestinae). Figured ovotestes, prostates and jaws are used for the separation of the major divisions.—H. B. B.

ABOUT ANATOMY AND SYSTEMATICS of subgenus *Carinogyraulus* (Gastropoda, Planorbidae). By Ja. I. Starabogatov. Nauchn. Dokl. Byssh. Shkol. (Sci. Rept. of Superior School), Biol. no. 4:16-20, 4 figs. 1958.—In this subgenus of *Anisus*, genitalia, radulae, jaws and pallial complexes of "*Gyraulus*" (*C.*) *trape-*

zoides robustonudus, *G. (C.) paradoxus* and *G. (C.) lychnidicus* are described and figured.—H. B. B.

MATERIALEN ZUR KENNTNIS DER ZONITIDEN (Gastropoda) des Kaukasus und der Krim. By Adolf Riedel. Ann. Zool. Polska Akad. Nauk 17 (11):383-427, pls. 29-30, 1 map, 14 textfigs. 1958.—The morphology and distribution of one Crimean and 4 Caucasus species of *Oxychilus* are studied carefully. These are distributed in subgenera *Schistophallus*, *Cellariopsis*, *Morlina* and (new) *Longiphallus*, type *Helix filicum* Krynicki.—H. B. B.

ON THE MOLLUSCAN ADHESIVE EPITHELIUM. By Bengt Hubendick. Arkiv för Zool. 0 (7118):001-006, 1 fig., pls. 1-3. 1957.—In *Ancylus lacustris*, the cells at the retractor attachments have microvilli, which apparently fit into minute shell depressions.—H. B. B.

THE DEVELOPMENT OF THE PENIAL STYLET in *Gyraulus* (Moll. Pulm.). By Bengt Hubendick. Arkiv för Zool. 11 (24):427-429, 4 figs. 1958.—All the stylet is secreted by surrounding epithelia, and later protrudes.—H. B. B.

A NOTE ON PROTANCYLUS P. & F. Sarasin. By Bengt Hubendick. Beaufortia 6 (78):243-250, 9 figs. 1958.—Additional anatomic data indicate that this genus belongs in the Planorbidae.—H. B. B.

A NOTE ON THE TAXONOMY OF THE BRAZILIAN VECTOR SNAILS OF "*Schistosoma mansoni*." By Bengt Hubendick. Rev. Brasil. Biol. 18 (1):37-40. 1958.—Prefers *Biomphalaria* to *Taphius*. Again, why not *Planorbina*? Or *Australorbis*, which is in most general use?—H. B.B.

STUDIES OF THE GENUS GUNDLACHIA (Pulmonata, Ancyliidae). By Paul F. Basch. Occas. Papers Mus. Zool. Univ. Mich. no. 602, 9 pp., 2 figs. 1959.—The status of the genus (sensu lato) remains uncertain, but the radula of *G. (Kincaidilla) meekiana* is unlike that of the typical group. It is like that of *Laevapex*, 1903, which unfortunately was made prior to *Ferrissia*, 1903, by Hannibal, 1912.—H. B. B.

PRELIMINARY STUDY OF NEWLY HATCHED OYSTER DRILLS, *Urosalpinx cinerea* (Say). By Melbourne Romaine Carriker. J. Elisha Mitchell Sci. Soc. 73 (2):328-351, 10 figs. 1957.—Reactions of baby drills to water currents, light, gravity, substrata, evaporation, and emanations from young hard clams were tested in the laboratory. They were voracious and very active.—H. B. B.



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CARIBBEAN SPECIES OF TRUNCATELLA

By ALFREDO DE LA TORRE

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Pfeiffer (1839:356) in the report about his trip to Cuba, describes the species *Truncatella pulchella* as follows: "Testa imperforata ovato-cylindrica, gracili, pellucide fulva; anfract. 4 minutissime striatis, ad suturam subcrenulatis, ultimo semistriato; peristomate crasso, albido; apertura subelliptica. Long. 2, diam. $1\frac{1}{2}$ ". Operculum tenue corneum."

In studying this description, I conclude that this is a species of about 4.36 mm. length (= 2 German lines), with rather obsolete axial sculpture, and a thick peristome.

One year later (1840:253), in the continuation of the report, the same author describes *T. bilabiata* as follows: "Testa cylindracea solidula, niti ce carnea, longitudinaliter confertim costulata; anfract. $4\frac{1}{2}$ convexis; sutura profunda; apertura obliqua ovali peristomate incrassato, duplicato, Long. $2\frac{1}{2}$ diam., $\frac{3}{4}$ lin."

This species is, according to the description, a little larger than *pulchella*, being of $2\frac{1}{2}$ German lines length (= 5.45 mm.), and having closely spaced longitudinal ribs.

Clench and Turner (1948:151) write the following about this species: "Our thanks are due to Dr. C. G. Aguayo for the gift of several lots of *Truncatella* from Cuba and for the loan of a type series of *T. pulchella* Pfeiffer, a series collected originally by Gundlach." In the same publication (pp. 156-158) these authors describe what they consider to be *pulchella* Pfr., based on a lectotype (Museo Poey 181, from Cardenas, Cuba) selected by them, and mention also other specimens considered by them to be paratypes, from the same locality, saying that: "Additional types are probably in the Museum of Stettin, Germany." (Loc. cit. p. 157).

In the same publication (p. 157) they stated that "*T. pulchella* is readily separated from *T. bilabiata* by being larger and having a simple lip," giving for their *T. pulchella* a length of

5.5 mm. (small specimens) to 7.3 mm. (large specimens). These dimensions do not agree with the original description by Pfeiffer of *pulchella*. This species is, according to Pfeiffer somewhat smaller than *bilabiata* and much smaller than the species supposed to be *pulchella* by Clench and Turner. On the other hand, the *T. pulchella* of Clench and Turner (not of Pfeiffer) is in perfect agreement in the characters, dimensions and figures, with *T. caribaeensis* "Sowerby" Reeve (1842:94, pl. 182, f. 2). The last name is, as far as I know, the earliest one available for this larger species of *Truncatella* of the Caribbean region. At the same time, I have proved to my satisfaction that *T. succinea* C. B. Adams (1845:12), described from Jamaica, is absolutely identical with *T. caribaeensis* "Sowerby" Reeve, which as the earlier name has priority. Dr. Morrison, who helped me in the preparation of this publication, agrees with me in these opinions.

As stated above, I have arrived at the following conclusions: (1) *T. bilabiata* Pfr. is only the strongly ribbed form of the previously published species *T. pulchella* Pfr. (2) The species called *T. pulchella*, by Clench and Turner in 1948 is not *pulchella* Pfr., and must be known as *T. caribaeensis* "Sowerby" Reeve, which is apparently the earliest name available for that species. It is larger than *pulchella* Pfr., with the outer lip of the peristome simple, and the lip usually thin.

In agreement with the foregoing, I have been able to examine numerous lots of *Truncatella* from Cuba and other Caribbean regions which prove that *T. pulchella* Pfr. (non Clench and Turner) is very variable, going from a smoothish form with the duplex condition of the outer lip and peristome in a very reduced or obsolete condition, to a form presenting strong axial ribs and with the duplex condition of the outer lip very prominent. This last form is what properly may be called *T. pulchella*, form *bilabiata* Pfr.

The typical *T. caribaeensis* "Sowerby" Reeve has well marked axial riblets and so is identical with *T. succinea* C. B. Adams; the smoothish form of this species was improperly called *T. subcylindrica* Gray, by Pfeiffer, in his writings. The true species *T. subcylindrica* (Linné) (= *laevigata* Risso) is a European species.

Going back to the problem of *T. pulchella* Pfr., I must point out that Clench and Turner (loc. cit. p. 151) are in error in considering a series of *T. pulchella*, from Cárdenas, Matanzas Province, Cuba, collected by Gundlach (from which these authors have selected a lectotype) as typical. As I have stated in previous paragraphs, I do not agree with them in considering this a type series of the species. At the same time I also suspect that this locality can not be considered the type locality (see A. Torre, 1952:19, also pp. 9 and 10). As I stated in 1952, Pfeiffer, during his trip to Cuba in 1839, visited only a few localities in the neighborhood of Havana and Matanzas and remained in Cuba only three months. So, the "neighborhood of the city of Matanzas" was probably the locality from which he collected the type specimens of *T. pulchella*; not from Cárdenas. It was only in 1841, two years after the publication of the original description of *pulchella* Pfr., that "Gundlach moved from 'El Fundador de Canimar,' Matanzas, to the 'Finca San Juan,' in Cárdenas, extending in this way his area of explorations" (A. Torre 1952:10).

The year 1856 (loc. cit. p. 193) is when Pfeiffer gave the localities in Cuba, for *T. pulchella* as "prope Matanzas et Cárdenas;" evidently collected by Gundlach at the last locality on a date posterior to the original publication of the species. Again, in 1857 (pp. 118-119) Pfeiffer lists the species of *Truncatella* of Cuba, giving under *pulchella* Pfr., the same localities as above; "Cárdenas and Matanzas, in the same living conditions as *subcylindrica*."

My only conclusion is that the selection of a lectotype by Clench and Turner for this species is inappropriate because the lot from which it was selected is not a series of *pulchella* coming from the original material collected by Pfeiffer and Gundlach in 1839. What is more important, it is not even a specimen of the species *pulchella* Pfr., but represents *caribaeensis* "Sowerby" Reeve, which is a different and larger species.

At the same time and in accordance with the foregoing statements, I am here restricting the type locality of *T. pulchella* Pfr. to the "vicinity of the city of Matanzas" and am considering the selection of a lectotype by Clench and Turner as invalid. It would be very interesting to know if there are typical speci-

mens of this species in the Museum of Stettin, Germany, as Clench and Turner suspect, and then to study them and get more detailed information about the type locality.

In 1856 (pp. 175-196) and again in 1857 (pp. 118-119) Pfeiffer listed the species of *Truncatella* of the Island of Cuba; the data given in both publications are in agreement with my conclusions. In the publication of 1857, the species listed for Cuba are the following: *T. caribaeensis* (with *succinea* as a synonym); *T. subcylindrica* (Gray) Pfr. [this is not, as I state in another part of this paper, the species *subcylindrica* (Linné), which is a European species, but only the smooth form of *caribaeensis* Reeve]; *T. bilabiata* ("collected under fallen leaves of *Coccoloba*, at the mouth of Canimar River, Matanzas, Cuba,") which is the type locality of this form (see A. Torre 1952:19); *T. scalaris* Michaud (Pfeiffer himself gives his *T. costata* as a synonym), collected at Matanzas, Cuba. The other two species listed as *Truncatella* (*elongata* and *lirata* Poey), are now known to be *Geomelania* and not *Truncatella*.

Pfeiffer, who was named "The Prince of Malacologists," was evidently a brilliant student of the genus *Truncatella* and his writings on this genus merit the most careful consideration.

I must cite also, in support of the conclusions herein adopted, the work by Küster (1855). In this publication, the figures and references given by the author absolutely support what I have stated in this paper. Also, W. G. Binney (1859:184-190) correctly described and figured *T. pulchella* Pfr., declaring on page 185 that "he had sent to Pfeiffer and Poey the Florida specimens of *Truncatella* and these were identified by them."

Before concluding these notes, I wish to make reference to the species *T. barbadensis* Pfr., listed by Clench and Turner (loc. cit. p. 153) in the synonymy of *T. bilabiata* Pfr. This species, Dr. Morrison has proved to me, is a good species, geographically limited to Barbados, W.I., and perhaps other lesser Antillean Islands.

Also I wish to refer to *T. scalaris scalaris* Michaud, and *T. scalaris clathrus* Lowe, which are distinguished from one another by the number of axial ribs on the body whorl, there being 8 to 11 in the typical form and 12 to 16 in *clathrus*. Since this character is variable and the two forms overlap on some of the

West Indian Islands, probably they can be considered only as simple forms of the same species, instead of as subspecies.

GENUS TRUNCATELLA Risso.

Truncatella Risso, 1826, Hist. Nat. de l'Europe Merid. 4, p. 124.

Type species: *T. laevigata* Risso (= *Helix subcylindrica* Linné) SD., Gude 1921 (According to Clench and Turner, 1948).

SUBGENUS TRUNCATELLA s. s.

TRUNCATELLA PULCHELLA Pfeiffer.

T. pulchella Pfr., 1839, p. 356 (Cuba). Küster, 1855, pp. 10-12, pl. 2, figs. 11-15. Pfr., 1856a, p. 192-193 (Cuba, near Matanzas and Cárdenas; Puerto Rico, Jamaica and St. Thomas [Gives as dimensions $4\frac{1}{2}$ mm. length \times $1\frac{1}{2}$ to 2 mm. width]). Binney, 1859, p. 189, pl. 75, fig. 10 (W.I. and Fla.). Binney, 1865, p. 99.

T. bairdiana C. B. Ads., 1852, Ann. Lyceum Nat. Hist. N. York 5, p. 437 (p. 213 in separate) ([West] Panamá). Clench and Turner, 1948a, p. 153, pl. 66, fig. 7 [Occurrence in West Panamá due to accidental transport from east coast?].

T. capillacea "Gundlach" Pfr., 1859, p. 77 (Caimanera, Guantánamo, Cuba). Clench and Turner 1948a, pl. 66, fig. 6 (Same locality).

T. bilabiata Pilsbry, 1948 p. 1069, fig. 571b (in part). Clench and Turner, 1948a, p. 153 (in part).

Type locality: "Vicinity of Matanzas City, Matanzas Prov., Cuba" (herein restricted). Other localities: In Cuba: Matanzas and Cárdenas (Pfr.); Playa Bellamar, Matanzas (A. Torre!); "El Embarcadero," Finca Bacunagua, Los Palacios, P. del Río (A. Torre!); also, Jamaica, Haiti, Florida (East and West Coast), Bahamas and St. Croix (USNM).

TRUNCATELLA PULCHELLA Pfr., form BILABIATA Pfr.

T. bilabiata Pfr., 1840, p. 253 (Cuba. 1856, p. 192 (Cuba: "Right bank of the mouth of the Canimar River, Matanzas (Gundlach), but not in the Island of Carmen, Gulf of México (Küster).") Pilsbry 1948, p. 1069, fig. 571a (in part). Clench and Turner 1948a, p. 153-155 (in part). A. Torre, 1952, p. 19. [The type locality is fixed, according to previous restriction by Pfeiffer in 1856].

Type locality: Right bank of the mouth of the Canimar River, Matanzas, Cuba. Other localities: In Cuba: Baracoa and Gibara, Oriente (Gundlach) (Acc. to Pfr.); "El Embarcadero," Finca Bacunagua, Los Palacios, P. del Río (A. Torre); Bueyvaquita, Matanzas (1 specimen, dead, in sand dredged) (A.

Torre!); Playa de Bellamar, Matanzas (A. Torre!) (Very common in this last locality in a cave in the seashore, etc.).

In the lots of *T. pulchella* Pfr. from Jamaica, Haiti, Florida, Cuba, Bahamas and St. Croix, that I have studied at the USNM., there are usually mixed specimens of the typical smoother form (*pulchella*), and of the costate form (*bilabiata*), but generally the smoother form is scarce and the costate form very abundant. From the Bermuda Islands there are several lots, but, in these, all the specimens observed by me belong to the costate form or *bilabiata* Pfr. The records given by Clench and Turner as *bilabiata* (loc. cit.) from Barbados, W.I., really belong to the species *barbadensis* Pfr. The species *pulchella* and the form *bilabiata* apparently do not live at that locality.

TRUNCATELLA CARIBAEENSIS "Sowerby" Reeve.

T. caribaeensis "Sowerby" Reeve, 1842, p. 94, pl. 182, fig. 7 (not fig. 2, as inadvertently given by Clench and Turner in 1918) (No locality given.) Küster, 1855, p. 9, pl. 1 figs. 35-37 and pl. 2 f. 1-4 [these last four figures correspond to the smoother variety, improperly called *subcylindrica* Gray, by Pfeiffer] (West Indies, México and Alabama). Pfeiffer, 1856, p. 185 (Cuba and Jamaica). Pfeiffer, 1857b, p. 119 (Vicinity of Matanzas, Cuba and Island of Jamaica).

T. succinea C.B.Ads., 1845, Proc. Boston Soc. Nat. Hist. 2, p. 12 (Jamaica). Pfr., 1846a, p. 118.

T. gouldii Pfr., 1846a, p. 118, Pfr., 1846b, p. 183 [in synonymy of *caribaeensis* Reeve].

T. caribaeorum Pfr., 1846a, p. 118.

T. variabilis Pfr., 1846b, p. 183 [nude name in the synonymy of *T. caribaeensis*].

T. guerinii "Parreyss" Pfr., 1856 p. 185 [nude name in the synonymy of *T. caribaeensis*].

T. subcylindrica (Gray) Pfr., 1856, p. 186-187 (in part) (Cuba: Matanzas and Cardenas); (Puerto Rico, St. Thomas Bermuda, etc.). Pfeiffer 1857b, p. 119 (= *caribaeensis* Küster, 1855, T. 2, f. 1-4, sec. Pfr.) Cárdenas, Matanzas Prov. Cuba). Non *T. subcylindrica* Linné, 1767, Syst. Nat. 12th. Ed. p. 1248 (Europe). [This is the smooth form of *caribaeensis*; typical *caribaeensis* being regularly axially striate].

T. pulchella Pilsbry, 1948, p. 1070, fig. 572b, c. Clench and Turner 1948a, p.156, pl. 68, f. 1-6 [Non *pulchella* Pfr. 1839].

T. pulchella form *caribaeensis* Pilsbry 1948, p. 1071, fig. 572 a.

Type locality: Cuba (?) (As I have not seen the reference by Pfeiffer in 1846 (p. 183) in which this author probably gives Cuba as locality, I am considering this as type locality with

doubt, until I can check that reference. Other localities: North Carolina, Fla., Texas, Bermuda, Bahamas, Cuba (Playa de Manimani, P. Rio); Cárdenas (Varadero), Matanzas; punta Alegre, Camagüey; Punta de Piedra, Banes, Cabo Cruz, Oriente; Isla de Pinos; Porto Rico, Virgin Islands (St. Thomas and St. Croix); Jamaica; Hispaniola (Haiti); Lesser Antilles (St. Bartholomew, Martinique, Guadeloupe, Barbados, Trinidad, Curaçao); all given by Clench and Turner, 1948: 157-158), (under the name *pulchella*). Bahamas, Cuba (Cabo Cruz, Matanzas); Hispaniola (Haiti); Jamaica; Cayman Ids. (Given by the same authors under the name *succinea* C. B. Ads., loc. cit. p. 159). Playa de Bellamar, Matanzas, Cuba (A. Torre!) (Common); Matanzas (Cuba) and Jamaica (Pfr.); Cárdenas, Matanzas Prov. (Pfr.); W. Indies, México and Alabama (Küster).

In the USNM, there are records from Cuba of several localities: Isla de Pinos; Little Cayman; Jamaica; Hispaniola (Haiti); Porto Rico; Virgin Is.; Guadeloupe; Trinidad; Bermuda; Florida (East and west coasts); Texas; Bahamas and St. Croix.

SUBGENUS TOMLINITELLA Clench and Turner.

Tomlinella Clench and Turner, 1948a, p. 159 [non *Tomlinella* Viader 1938, Bull. Mauritius Inst. 1: 6].

Tomlinitella Clench and Turner, 1948 b, p. 169.

Type species: *Truncatella scalaris* Michaud, (OD.)

TRUNCATELLA SCALARIS (Michaud).

Rissoa scalaris Michaud, 1830, Descr. Genre Rissoa p. 18 (Locality unknown).

Truncatella costata Pfr., 1839, p. 356 (Cuba).

Truncatella cumingii C.B.Ads., 1845, Proc. Boston Soc. Nat. Hist. 2, p. 12 (Jamaica). Pfeiffer, 1846a, p. 119 [declared identical to *T. costata* Pfr.]

Truncatella scalariformis C.B.Ads., 1845, loc. cit. p. 12 (Jamaica) (Non Reeve, 1842) (Acc. to Clench and Turner, 1948a: 160).

Truncatella adamsi Pfr., 1846a & 1846b, pp. 119 & 189 [New name for *scalariformis* C.B.Ads., non Reeve 1842].

Truncatella scalaris Pfeiffer, 1856, p. 194-195 (Cuba and Jamaica).

Truncatella (Tomlinella) scalaris Clench and Turner, 1948a, p. 160-161, pl. 71, fig. 1-4 [figures 5 and 6 of the same plate probably belong to the subspecies *clathrus* Lowe.]

Truncatella (Tomlinitella) scalaris Clench and Turner 1948b, p. 169.

Type locality: Port Antonio (Jamaica) (Neoholotype designated by Clench and Turner from that locality 1948a; 161). Other localities: Cuba; Hispaniola (Haiti); Jamaica (Clench and Turner); Matanzas, Cuba (Pfr.); Jamaica (Pfr.); Playa de Bellamar, Matanzas, Cuba (scarce) (A. Torre!). Haiti, Jamaica and St. Croix (USNM.) (Teste Morrison). (See also under *T. scalaris clathrus*).

TRUNCATELLA SCALARIS CLATHRUS LOWE.

T. clathrus Lowe 1832, Zoological Journ. 5, p. 303 (Locality unknown). Reeve, 1842 p. 94, pl. 182, fig. 3 (no locality given) [This is the first figure of this species]. Shuttleworth, 1852, p. 155 (Porto Rico and St. Thomas). Pilsbry 1948, p. 1069, f. 571c.

T. clathra Pilsbry 1900, p. 506, pl. 62, fig. 13 (Bermuda Ids., Porto Rico and St. Thomas.)

T. scalaris piratica Clench and Turner 1948a, p. 161, pl. 72, fig. 1-4 (Bermudas). (Teste Morrison).

T. (Tomlinitella) scalaris piratica Clench and Turner, 1948b, p. 169.

Type locality: (?) according to the literature (Shuttleworth, 1852: 155) the restriction of the type locality to Puerto Rico seems possible, as this author cites this form from Puerto Rico and St. Thomas (collected in the last locality by Blauner). But we have not seen a single specimen of *T. scalaris* (Michaud) or of *T. scalaris clathrus* Lowe from either one of those two localities, so, we are in doubt if this species or the form *clathrus* really live on Porto Rico and St. Thomas or not. Other localities: Bermuda Islands (Clench and Turner); Cuba, Haiti, Florida, Bahamas. The localities in Cuba being Varadero, Matanzas; Bahia de Cabanas (P. Rio) (USNM. collection). Also: Playa de Bellamar, Matanzas (in sand, mixed with *T. scalaris scalaris*) (Michaud) both of them being rare (A. Torre!).

This form is distinguished from the typical one because it has 12-16 axial ribs in the body whorl, instead of 8-11 as in the typical *scalaris* (Michaud). According to Dr. Morrison, these two forms seem to have a different geographic distribution, although they overlap in Haiti, and, according to specimens collected by the writer they overlap in Cuba also. Dr. Morrison thinks that the specimens coming from Florida and the Bahamas in the collection of the USNM. all correspond to the form *clathrus* and none to the typical *scalaris* Michaud. I keep them separate, as distinct subspecies, although they possibly may prove to be only different extreme forms of the same species.

TRUNCATELLA BAHAMENSIS Clench and Turner.

T. bilabiata bahamensis Clench and Turner 1948, *Johnsonia*, vol. 2 no. 25, p. 155, pl. 67, f. 1-3.

Type locality: Northwest Point, Little Inagua, Id., Bahama Ids. Other localities: Limited to the Bahama Islands.

TRUNCATELLA BARBADENSIS Pfeiffer

T. barbadensis Pfr., 1856, p. 192 (Barbados). Pfeiffer, 1857a, p. 337 (Barbados, W.I.).

T. bilabiata Clench and Turner 1948a, p. 153-155 (in part).

Type locality: Barbados, Lesser Antilles. Other localities: in the collection of the USNM. There are records of this species from several localities in Barbados and also, records of a small form of the species from Guadeloupe and Antigua (teste Morrison). The records given by Clench and Turner in 1948 (p. 155) for *bilabiata*, from Barbados, probably correspond to this species, these authors giving the name *barbadensis* as a synonym of *bilabiata* Pfr. I think that they are really different species, *barbadensis* being always strongly axially ribbed as well as different in shape and other characters. The previous study by Dr. Morrison on specimens of the collection of the USNM. is in perfect agreement with my conclusions here.

I wish to acknowledge here my gratitude to Dr. Joseph P. E. Morrison, for the valuable help given to me in preparing these notes and list.

Key to the western Atlantic and Caribbean species of *Truncatella*.

Shell small (3-6 mm. total length). Outer lip generally duplex
Costae 17 or more on the body whorl; no microscopic spiral
sculpture between the ribs.

Shell smoothish. Duplex condition of the outer lip somewhat obsolete *T. pulchella*.

Shell not smoothish. Duplex condition of the outer lip well marked

Shell narrower and more cylindrical and elongated than the following group (4 to 5 remaining whorls in the adult shell).

Axial ribs numerous and close together (about 40 on the body whorl) *T. barbadensis*.

Axial ribs generally less numerous and more widely spaced than in the preceding species (about 20 on the body whorl) *T. bahamensis*.

Shell shorter and less cylindrical (3 to 4 remaining whorls in the adult shell) *T. pulchella*, form *bilabiata*.

Costae 16 or less on the body whorl; microscopic spiral sculpture between the ribs.

- Costae 8 to 11 on the body whorl *T. scalaris*.
 Costae 12 to 16 on the body whorl *T. scalaris clathrus*.
 Shell larger (6 to 8 or 9 mm. in length). Outer lip simple. Axial
 costae well developed or more or less obsolete *T. caribaeensis*.

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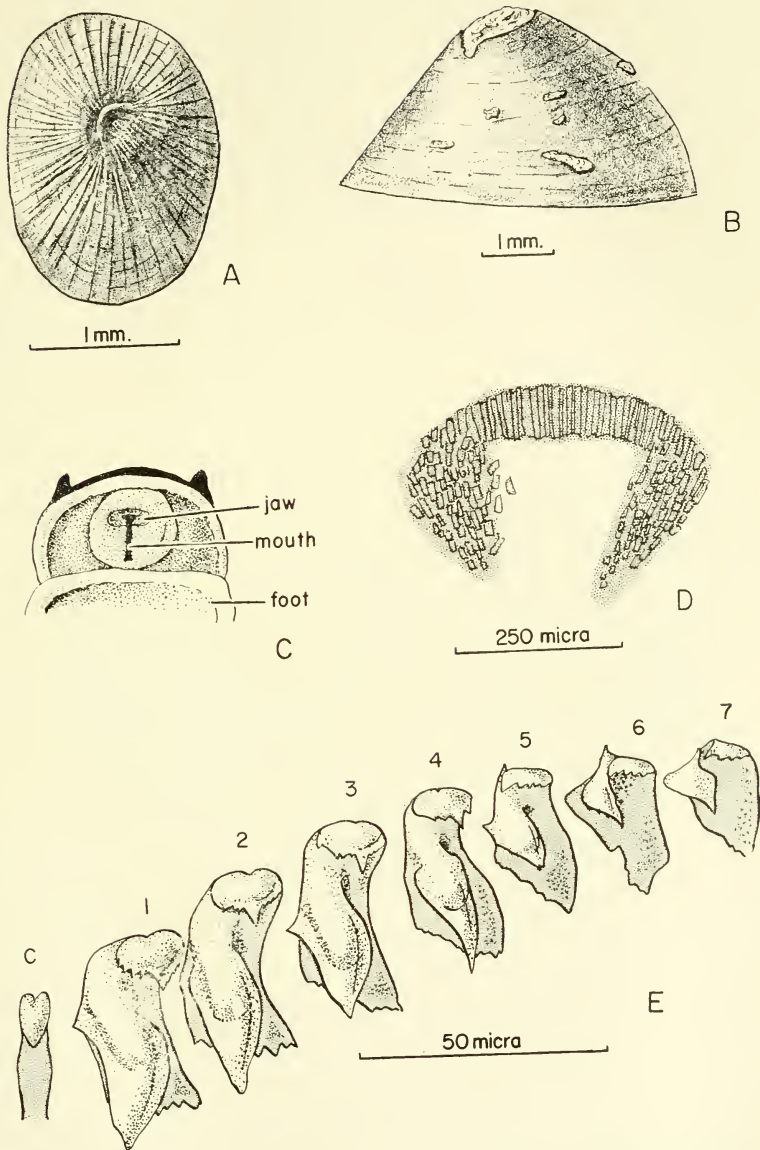
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ANATOMY OF RHODACMEA CAHAWBENSIS WALKER, 1917, A RIVER LIMPET FROM ALABAMA

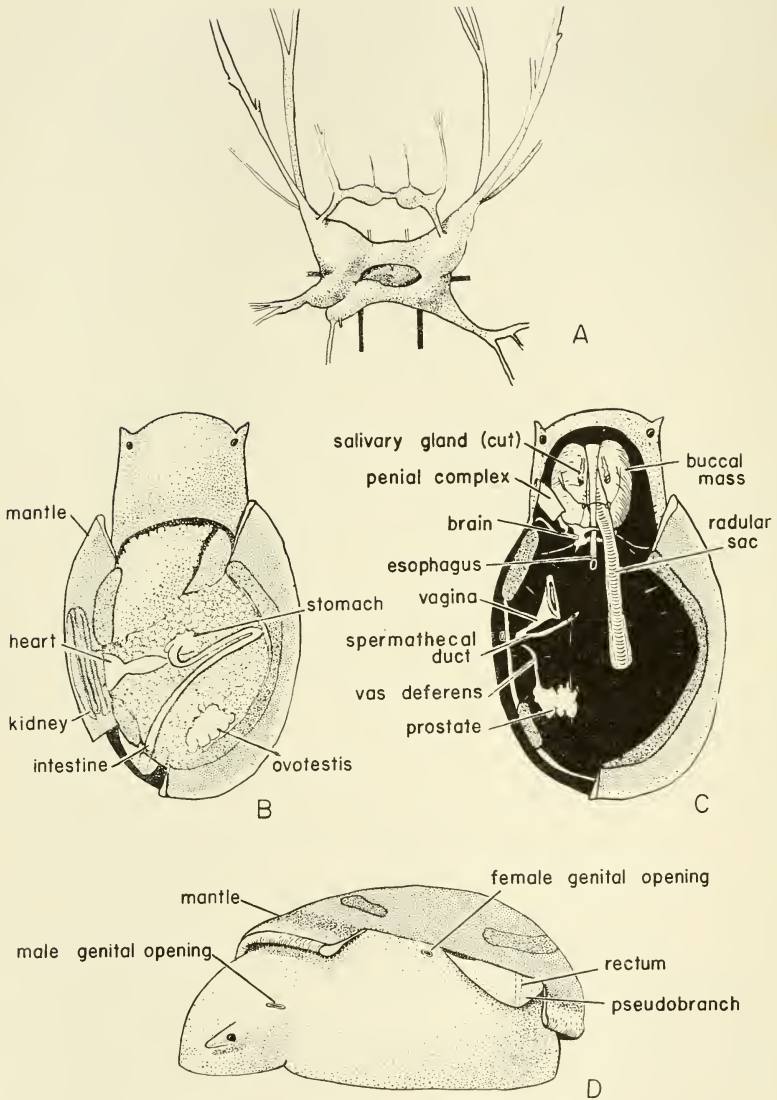
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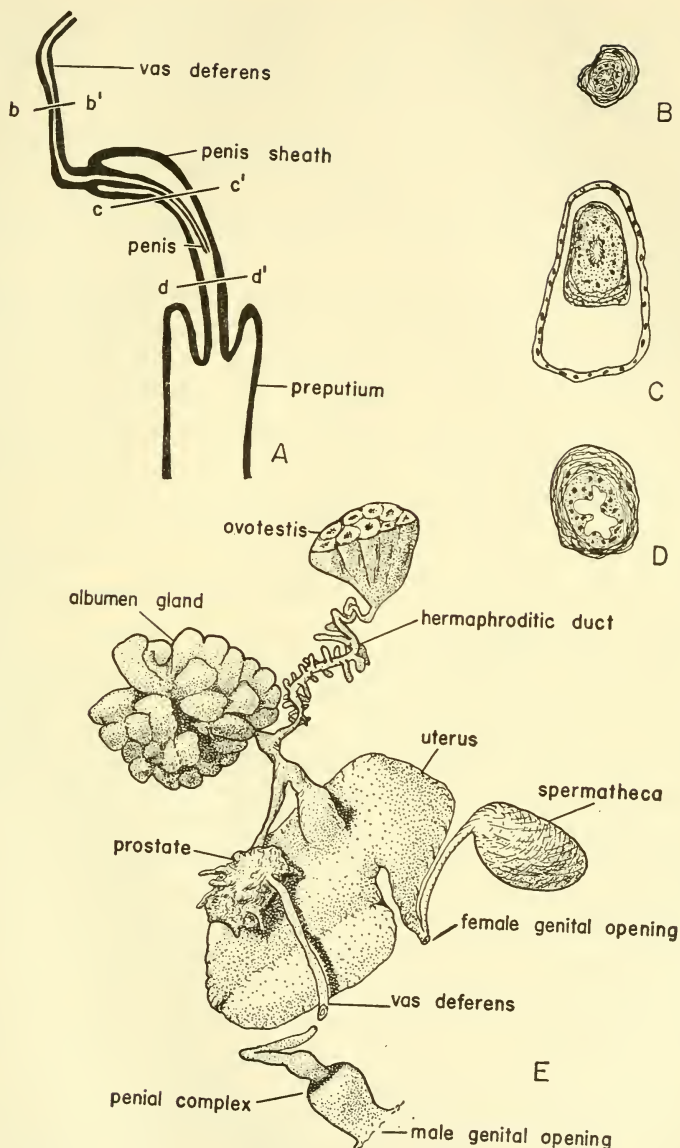
The genus *Rhodacmea* was established by Bryant Walker in 1917 to include a number of limpet-like freshwater mollusks, found mainly in the southeastern United States. Heretofore, nothing has been known of the anatomy of these snails besides the shell and radula, both of which present distinctive features.



A: Shell of juvenile specimen of *Rhodacmea cahawbensis*, dorsal view; note depression near left side of apex. B: Shell of adult specimen of *R. cahawbensis*, right side view; note erosion of apical region. C: Ventral view of head region. D: Jaw, dissected from an adult specimen, flattened. E: Central and first 7 lateral teeth of radula; marginals not shown.



A: Central nervous system of *Rhodacmea cahawbensis*. B: Superficial dissection of animal to show relative positions of organs in life. C: Deeper dissection; most of the digestive and reproductive systems removed. Note positions of shell muscles. D: View of left side of adult specimen, shell and portion of mantle containing kidney removed. Note position and character of pseudobranch.



A: Penial complex of *Rhodacmea cahawbensis*, semidiagrammatic. B: Section of vas deferens, through plane b-b' on A; note ciliated lumen. C: Section through penis and penis sheath at plane c-c' on A. D: Section through penis sheath at plane d-d' on A. E: Reproductive system of *R. cahawbensis*, dissected out and separated to show relationships of organs.

The apex of the shell in all species is tinged with a reddish coloration, and a thick callus of shelly material usually is found within the apical region. The enormous, unusually shaped lateral teeth of the radula (pl. 7, fig. E), the small marginals and the small number of teeth per row have cast doubt upon the validity of associating *Rhodacmea* with the family Ancyliidae. The present investigation was undertaken to determine the proper systematic position of this genus through anatomical study.

The specimens used were collected by the author and Dr. John B. Burch on June 6 and June 8, 1959, from stones and dead mussel shells in rapids of the Cahaba River west of Helena, Section 19, T 19S, R 4 W, Shelby County, Alabama. Identification as *R. cahawbensis* was made by comparison with the holotype specimen, No. 102635, in the collection of the University of Michigan Museum of Zoology. The type locality for the species is at Gurnee, Shelby County, Alabama, about 8 miles south of the Helena location. Specimens from the present collection have been deposited in the University of Michigan Museum of Zoology.

I am greatly indebted to Dr. Henry van der Schalie for making the collecting trip possible and for the generous use of his facilities, and to Dr. Harold W. Harry, of the University of Alabama, Birmingham Center, for invaluable assistance in the field.

In spite of unusually high waters which made collecting difficult, sufficient specimens were secured to make a thorough anatomical study of *R. cahawbensis* possible. The animals were placed in a 1% solution of Nembutal until relaxed, fixed in the field with formalin-acetic acid-alcohol fixative, and stored in 70% alcohol. A few specimens were brought back to Ann Arbor alive, but they did not survive more than four days even when packed in ice. Gross dissections were made of 8 specimens, and one was embedded in paraffin and sectioned serially at 10 microns, for histological study. Radulae of adult and juvenile animals were removed, cleaned in dilute sodium hypochlorite solution, stained with Orange G, and mounted in Canada Balsam or Euparal.

Shell: The shells of the juvenile specimens are distinctly radially striate, and show a characteristic pit-like depression on

the left side of the apex (pl. 7, fig. A.) The precise form of this depression varies somewhat among the specimens collected, but it is present in all. Both the depression and striae usually are lost in the adult when the apex becomes eroded, and are not apparent on the holotype. Both of the characters, however, are present in adult UMMZ. specimens of *Rhodacmea filosa* (Conrad) from the Coosa River, Alabama, and in certain lots identified as *R. elatior* (Anthony) from Eagle Creek, Owen County, and Green River, Hart County, Kentucky. The utility of these apical characters as taxonomic markers is unfortunately diminished by the erosion so frequently encountered in certain species.

Juvenile shells are a rusty brownish color when collected, and shells of the adults (pl. 7, fig. B) are black, often with tiny clumps of algae growing on them. When cleaned with dilute oxalic acid, the periostracum is revealed as a thin, light corneous layer over the shell, and in those specimens in which the apex is at least partially retained, the pink coloration becomes evident.

External morphology: The animal of *R. cahawbensis* is superficially bilaterally symmetrical, resembling other ancyliid genera in this respect. The head and foot are a light gray color, and the translucency of the tissues permits the color of the internal organs to show through. The relatively large head bears prominent eyes and much reduced tentacles, through the thin integument of the front of the head the pink buccal mass is clearly visible. Beneath the shell, the color of the dorsal surface of the mantle is quite variable. In some specimens, it is uniformly gray with a concentration of pigment near the periphery giving the effect of a black ring, in others pigment is almost entirely absent or may appear only as irregular black blotches. The pseudobranch is small and simple, without folds or ridges, and bears the rectum and anus. The foot is broad, flat, and oval in outline, as in other ancyliids.

Integument and muscles: The integument of *R. cahawbensis* presents no peculiarities, and histologically is similar to that described by Basch (1959) for *Laevapex fuscus*. The foot and velar muscles are also similar to the latter species, but the right anterior shell muscle in all specimens examined extends a much greater distance caudally than does the homologous structure

in *Laevapex* or *Ferrissia*. The placement of shell muscles in *Ancylus fluviatilis* is different from that of any of the American forms yet examined, and in the more distantly related *Acroloxus lacustris* the pattern is again different. When more genera of the family Ancyliidae become known anatomically, this may show that the pattern of shell muscle distribution is significant in tracing relationships.

Respiratory system: The pseudobranch (pl. 8, fig. D) described above, resembles that of *Ferrissia* or *Ancylus*, and not the far more complex structure found in *Laevapex*. The pulmonary cavity is almost obsolete, its opening represented only as a narrow horizontal slit just dorsal to the anterior part of the pseudobranch. Undoubtedly, the habitat of this species, in rapids of a swiftly-flowing stream, permits it to obtain sufficient oxygen through the general body covering and renders a highly developed respiratory structure unnecessary.

Digestive system: The general plan of the digestive tract is much the same as that of *Ferrissia*, *Laevapex*, or *Ancylus*. The salivary glands, fused posteriorly, are longer than those presently known from any other American form, but the most striking feature of the digestive system is the extraordinarily long radular sac. This structure (pl. 8, fig. C) extends well back into the body, as in *Ancylus fluviatilis*, the common river limpet of Europe. Whether the conformation of the radular sac is dependent upon the diet of these animals, or whether it reflects phylogenetic relationships, is at present unknown.

The peculiar radula was used as a major criterion for establishing the subfamily Rhodacmeinae by Walker (1917), and is difficult to interpret in view of the strong similarities in other features between *Rhodacmea* and other ancyliid genera. The jaw (pl. 7, fig. D) with its many small lateral elements, resembles that of *Ancylus* far more closely than it does any of the known American species (cf. Hubendick, 1947: fig. 15).

Excretory system: The kidney of *Rhodacmea* shows the characteristic pattern of flexures found in other ancyliid snails (with the exception of *Acroloxus*), and histologically presents the same picture. The shape of the kidney appears to be a far more conservative character than radular or reproductive structures and may be useful in the discrimination of phylogenetic groups

within the family.

Nervous system: The brain (pl. 8, fig. A) is much the same as that of *Laevapex*, and of Basommatophora in general. The size, shape, and number of otoliths in the statocysts agree with those of *Laevapex*. Eyes and osphradium show no peculiarities.

Circulatory system: The structure, position, and relations of the heart (pl. 8, fig. B) are as in *Laevapex*, *Ferrissia*, and other sinistral ancyliids.

Reproductive system: In this system, *Rhodacmea* differs from the other genera of ancyliids whose anatomy is known. The ovotestis has relatively few follicles (8 to 10), resembling that of *Ferrissia* and *Ancylus*. The seminal vesicle is a variable structure, probably changing shape in all species according to the progress of the breeding season. In the specimens of *Rhodacmea* examined, the seminal vesicle consists of a number of papillose side branches of the hermaphroditic duct (pl. 9, fig. E) appearing identical in shape to that of *Ancylus* (Lacaze-Duthiers, 1899), and similar to *Ferrissia parallela* (Baker, 1928). In *Ferrissia tarda*, the seminal vesicle is a simple sac (Hoff, 1940), and in *Laevapex fuscus* it is a greatly expanded structure as large as the ovotestis (Basch, 1959).

The albumen gland in the living *Rhodacmea* consists of a number of glistening, bright yellow, elongated pear-shaped follicles which collapse quickly when placed in fixative. In shape, this structure resembles the homologous gland in *Ancylus*.

The organ here called the uterus is actually a compound gland composed of at least 3 clearly differentiated histological regions, one or more of which may represent the separate nidamental gland as found in other ancyliids and many other Basommatophora. In the family Planorbidae, there is a tendency for this gland to become incorporated into the wall of the uterus (Baker, 1945), and, in such forms as *Laevapex fuscus*, it is difficult to distinguish uterine from nidamental tissue. The dorsal wall of the hollow uterus is greatly thickened in the head region, where it extends forward over the penial complex and part of the buccal mass. The cytoplasm in this area stains a smooth light gray color with haematoxylin and eosin, and nuclei are very scarce. This appears to be a storage area. The thickened area tapers off gradually posteriad, and disappears at about the

level of the left anterior shell muscle. Here the lateral wall of the uterus consists of an extremely active secretory epithelium whose many cells are filled with cords of brilliant red-staining droplets, present in enormous numbers. The third kind of tissue, folded in a complex pattern, is found in the medial wall of the uterus and continues posteriad. Here the cytoplasm shows a deep blue velvety appearance, with few nuclei. This area is that which connects proximally with the other organs of the reproductive system.

The prostate is an irregularly shaped extension of the vas deferens, and in some specimens seems almost to be connected with the portion of the uterus just described. The characteristic pattern of folded lobes which is found in *Laevapex* and to some extent in *Ferrissia parallela* is entirely absent in *Rhodacmea cahawbensis*. The distal portion of the male system (the penial complex) is unique among the known ancyliids. The penis is simple (pl. 9, fig. A) showing neither the ultra-penis arrangement found in *Laevapex* nor the flagellar structure found in various modifications in *Ferrissia* species and in *Ancylus*.

Relationships: Only a relatively small number of the dozens of described species of ancyliids have been dissected, so that meaningful evaluations of the significance of anatomical characters are extremely difficult. Still, something can be said about the relationships of *Rhodacmea*. The general body morphology, kidney, brain, pseudobranch, and digestive tract (except for the radula) all show that *Rhodacmea* is indeed an ancylid snail and related to the other genera mentioned in this paper. Several features, such as the shape of the jaw, the radular sac, and the albumen gland seem to indicate an affinity with the genus *Ancylus*, although these resemblances may be superficial and coincidental. The shell, radula, and penial structure, which all are unique among ancylid snails, support the separation of *Rhodacmea* as a genus, and these characters probably have sufficient weight to uphold Walker's separation of the Rhodacmeinae as a distinct subfamily.

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EDITOR'S NOTE. For the benefit of those accustomed to the Pilsbryan anatomic terms, which long have been established in geophile Pulmonata, the "penis" in the preceding paper is a verge or penial papilla; the "penial complex" corresponds to an introverted penis; and the "flagellar structure" is a penial appendix, on the vergic sheath or capsule. Dr. Pilsbry, since 1895, employed flagellum for a free appendix or caecum on the epiphallus, which is not developed in the limnophiles.—H. B. B.

STUDIES ON MOLLUSK POPULATIONS: 4

By R. STOHLER

(Concluded from October no.)

As will be noted from Table 3, concerning specimens collected at Duxbury Reef only, throughout the second half of the year 1950, there was a variation in the indices for this locality almost as large as that in the entire area represented by Table 2. At Duxbury Reef, *O. biplicata* varied from a slender 45.90 to an obese 64.81. Oldroyd's varieties vary, similarly, from a slender 47.06 to an obese 61.74 (not differentiating between the several "varieties," but all taken together). Thus, the population at Duxbury Reef well exceeds in its variations the varieties singled out on what seem to have been purely subjective impressions by T. S. Oldroyd. As may be stated, then, this study reinforces the opinion of several authors as implicitly expressed (the Giffords, 1944, state: ". . . seems to indicate that Mr. Oldroyd dignified mere individual variations by names, rather than . . .", and Keen, 1937, omitted listing the varietal names in the check list).

Table 3: *Olivella biplicata* (Sowerby), collected in 1950 at Duxbury Reef, Marin County.

collecting dates	I 1 VI	II 17 VII	III a 29 VII	III b M. P.	IV 26 VIII	V 12 X	VI a 9 XI area A	VI b area B	VII 23 XI	VIII 7 XII	IX 21 XII
number of specimens	126	881	125	22	22	6	255	395	341	153	115
largest specimen { length width index	312 165 52.88	294 152 51.70	269 144 53.53	267 145 54.31	272 156 57.35	259 134 51.74	307 161 52.44	276 150 54.35	291 166 55.67	276 147 53.26	301 147 48.84
smallest specimen { length width index	186 107 57.53	105 62 59.05	163 93 57.06	202 116 57.43	172 96 55.81	217 119 54.85	116 69 59.48	119 74 62.18	128 73 57.03	138 81 58.70	147 82 55.78
slenderest specimen { length width index	257 132 51.36	220 109 49.55	215 108 50.23	263 134 50.95	254 132 51.97	259 134 51.74	294 143 48.64	230 118 51.30	264 133 50.38	234 119 50.85	268 123 45.90
most obese specimen { length width index	233 151 64.81	183 118 64.48	175 112 64.00	207 132 63.77	226 135 59.73	244 138 56.56	204 125 60.98	119 77 64.71	200 125 62.50	215 131 60.93	233 142 60.94
average { length width index	236.53 135.13 57.25	208.06 118.08 56.75	218.98 122.83 56.18	221.09 123.09 55.75	230.34 129.41 56.19	232.83 127.00 54.58	249.56 136.78 54.76	200.48 113.91 57.03	230.53 127.74 55.51	220.23 123.24 56.05	243.89 133.72 54.94

The three varietal names given by Oldroyd have no taxonomic significance and should be relegated to the synonymy of *O. biplicata* (Sowerby).

As indicated before, several other observations were made in connection with this particular investigation which are considered worthy of record. In Table 2 are recorded measurements, etc., made on what appears as two separate lots from La Jolla, designated as I and II. Mr. Richard Shaw (see Stohler, 1952) collected both lots at one time in one spot. The present writer separated out from this single lot (and designated as II) all shells that showed peculiar brownish markings on the early whorls, reminiscent of *O. pycna* Berry. I thought that the markings might be an indication of hybridization, an idea which had to be abandoned very quickly, because no *O. pycna* were contained in that particular collection nor have any specimens of this latter species been collected at that locality since then. While lot II did not include as large a specimen as lot I, nor as obese a one, nevertheless the arithmetical averages are identical for all practical purposes. From observations made since that time, seemingly about one fourth of all *O. biplicata* shells show such brown lines on the early whorls and that this is merely another of the variables.

The smallest specimen in our collections obtained so far was gathered by Dr. Cadet Hand (Department of Zoology, University of California, Berkeley) in the harbor at Monterey (see Stohler, 1952). As the averages of this lot indicate, there was a greater proportion of small shells picked up than elsewhere. The sand in this harbor seems very fine and lacks coarse grains, pebbles and rocks. In other areas to be discussed presently, the sandy areas were not as uniform but included even fairly large rocks and the fine sand was limited to relatively small pockets. In attempts to section histologically fixed specimens, the stomach was found to be full of sand in every case, a fact which seems to indicate the olivellas ingest the sand in their feeding process. This in turn would lead to the assumption that the size of the sand grains might play an important role in the minimum size of animals to be found in a given spot; large olivellas can ingest coarse or fine sand while the small individuals would be limited to fine sand only.

The following two observations appear to support this idea. Columns VIa and VIb of Table 3 refer to two areas at Duxbury Reef; area A may be described as a very large, shallow tide pool in a sandy area, interspersed with large and small rocks and many pebbles of various sizes; area B was further seaward in an area devoid of all rocks, having only fairly uniform fine sand covering the area to a depth of about an inch. In area B, the population was somewhat denser and also showed a smaller average.

Mrs. Fay Wolfson of San Diego is carrying on at present a growth study on *Olivella biplicata* in the Flood Control Channel of that city. She discovered pockets of fine sand containing only small shells and she refers in her "unofficial" records to these areas as the "nurseries." Large specimens of this species are found elsewhere. Mention of any other facts uncovered so far in her study is not proper at this time, but this observation certainly appears to corroborate the assumption expressed above. As is necessary to mention at this point, these several observations will have to be considered again a little further below in connection with the breeding "season" of *Olivella*.

On the various collecting trips, I noted that, as soon as the cold waves washed over the previously exposed sand, the buried and apparently quiescent olivellas became active again; tracks immediately appeared and I also observed that there was a tendency for pairs to form, one individual following the other. Usually, such pairs eventually mated. This mating behavior was observed almost every time I was at Duxbury Reef, regardless of the time of the year, except when nightfall prevented the awaiting of the returning tides. Since this behavior was seen every month of the year, a safe conclusion is that *O. biplicata* does not have a limited breeding season and that, consequently, small or rather very young, as well as fully adult individuals should be found throughout the year. This latter expectation is borne out by Table 3. Thus from June 1 (indicated as 1 VI) to December 21 (21 XII), 1950, specimens of over 25 mm in length were found. The absence of the very small specimens can be ascribed, I think, to the lack of the very fine sand necessary for the young animals; I also suggest that the very young olivellas cannot maintain themselves in the shallower water where the

tidal changes cause a churning up of the sand and that they may be expected further down, where the wave action has less effect—or in protected bays and harbors. The latter seems to apply to the lot collected in Monterey Harbor, while the former seems to be the case with the “nurseries” in the Flood Control Channel.

The facts and observations just discussed also may apply in one way or another to the lot from Point Abreojos in the Oldroyd collection and designated as *O. biplicata parva*. On the other hand, for the time being at least, the possibility of conscious or unconscious selection on the part of Mr. Hemphill in collecting the lot cannot be excluded.

On July 29, 1950, 11 pairs of *Olivella* were collected; these were at the time actually mating; at first I thought that what had been termed obese shells might owe this fact to the sex of the animal, because logically the female with its ovary might require a more spacious shell than the male. This was, however, not borne out by the actual measurements. In the mating pairs (M. P. in Table 3), the animal plowing ahead is the female while the one following is the male (when the animals are separated from each other, the penis is always part of the second, i.e., posterior animal). The shell of the females in all 11 cases was longer than that of the male, the differences varying from 0.3 mm to 6.0 mm. As may be seen from the table in column III b, among the mating pairs the smallest animal was 20.2 mm long. Smaller mating partners have been observed (as stated above, a total of 49 mating pairs have been collected, but only the measurements etc. made on these initial 11 pairs are recorded here since the addition of the data from the other 38 pairs would not have altered the picture and merely added bulk), the smallest found being a male of 17.9 mm length mating with a female 27.0 mm long. Of the 11 pairs reported upon here, the female was more obese than the male in 6 cases, the male was more obese than the female in 5 cases. The greatest index difference between the two sexes was approximately 9.4 units in the group where the female was more obese (average of differences appr. 4.75 units); in the second group the largest index-difference was only 4.5 units and the average of the differences was about 2.36 units. One of the mating pairs collected on March 22, 1951, seems interesting; in this pair, the male (20.7 mm long, 12.5 mm

wide) had an obesity index of 60.39 while the female (24.0 mm long, 11.4 mm wide) had an obesity index of only 47.5, a difference of the two of 12.89; in other words, in this one case the male is even more obese than the female than in the reverse situation; but, of course, this is apparently an exceptional case and merely tends to emphasize the overall conclusion: relative obesity of the shell cannot be taken as a sex character in *O. biplicata*.

In Table 1 are recorded also the measurements and indices obtained from a lot of albino shells, labeled *Olivella lapillus* (Vanatta). While this varietal name has previously been relegated to the synonymy of *O. biplicata* (Sowerby) based on a study of color variations within unselected populations (Stohler, 1952), these measurements were made, nevertheless, in order to test the possibility that the white shells really were different in other ways than in pigmentation. However, as this rather small lot shows, the range of variation of this group falls well within the range of our species; thus, as far as size of the shell is concerned, the varietal name *lapillus* also appears not justified. In spite of these facts, in the studies reported on here, a note was considered desirable whenever a white shell was measured; also for the mating pairs this particular aspect was recorded. Without going into a tedious enumeration, the statement may be sufficient that in the tables of measurements and in the tables of the indices computed, the letter W (denoting white shell) appears in a random fashion. As should be stated, the two sets of tables for each lot were arranged from the shortest to the longest shell and from the lowest to the highest obesity index, respectively. The following list is a sample of the distribution of W in the first 100 (smallest) shells of lot XIII from Duxbury Reef (this lot included 1318 shells, of which 113 were white): Nos. 2, 9, 21, 45, 50, 56, 70, 93, were white, the other shells varied in color as previously reported. In the table of the obesity indices of the same lot XIII, the following were white shells among the 100 slenderest specimens: Nos. 5, 13, 52, 62, 84. As seems superfluous to mention, these order numbers are, of course, not the same as the ones in the previous list. As to the mating habits of the white *Olivella*, I may point out that there seems no color preference exhibited by the animals; for example in lot no. 9 from Duxbury, there was a total of 115 individuals collected; of these 12 were

mating; in one of the 6 mating pairs both partners were white, in one other pair one partner was white (the male) while the other partner was olive. The other four pairs showed random color distribution. On the other hand, in lot 11 (with a total of 137 individuals and also 6 mating pairs) no white animals were found in the process of mating. As perhaps is amusing to note, in all the other 37 recorded mating pairs, no white individuals were involved, which might lead to the erroneous conclusion that white olivellas don't mate! However, workers in the field of population genetics are well aware that such chance results are to be expected in small samples.

The question as to the presence of a real breeding season in *Olivella biplicata* at Duxbury Reef is not too readily settled. From my field notes and from my records, the following data shed some light on this problem: approximately 20% of all individuals counted on July 29, 1950, were mating; approximately the same proportion was counted on November 23, 1950; somewhat more than 10% were mating on December 21, 1950, January 23, 1951, February 20, 1951, about 12% on March 22, 1951, but only about 2% on April 24, 1951. Thus, two high peaks in mating activity were noted; but I cannot ascribe much validity to these numbers for the simple reason that the instances of little apparent activity occurred on the dates when either the lateness of the hour or rough weather prevented me from extending my observations over a period of about 90 minutes past the turning of the tide. I believe I may conclude safely that *O. biplicata* actually reproduces throughout the year, although possibly, at certain times, a greater percentage of the individuals in a given population mate than at other times. Also, as should be borne in mind, these conclusions are based on observations made on intertidal populations; what may take place in the subtidal area is yet to be explored.

The mating behavior, and perhaps consequently the breeding cycle, may be vastly influenced by meteorological phenomena. The numbers recorded in Table 3 show amazingly small numbers of olivellas collected in August and October of 1950. My field notes seem to me to contain the answer to this problem; I quote them verbatim:

"26. VIII. 1950: Apparently the shore was lashed very recently

by heavy waves judging by amount of drift on beach and by cover of fine silt over the sand. Only small number of *O. b.* was seen."

"12. X. 1950: Exactly same appearance as on 26. VIII. 1950; still fewer *O. b.* seen."

"9. XI. 1950: Water clear; no silt observed in entire area. *O. b.* present in large numbers, ca. 25% mating."

That the population did not die out during the 6 or 7 weeks of adverse conditions in the intertidal area is suggested by the size distribution of the group collected on November 9; comparing the data in Table 3 shows that this group fits in very well indeed with all the others. If, however, the population previously present was killed off by the presence of silt, then we would have to postulate that a very large population moved in rather rapidly from the subtidal region. This in itself is not impossible, and I assume that just such a situation did occur, namely the *olivellas* present moved out when conditions became adverse and returned when conditions improved again.

In conclusion, facts, observations and deductions may be summarized as follows:

Olivella biplicata (Sowerby) is a highly variable species throughout its range of distribution, varying from very obese to very slender individuals in any unselected population. Also it varies widely in color from almost entirely white to a very dark chestnut brown, almost black.

There is no apparent sexual dimorphism in this species, although in the measured mating pairs the female was, without exception, larger than the male. Size alone, however, would not be a satisfactory criterion to distinguish the two sexes as there is great overlap.

At Duxbury Reef in Marin County, California, there is no discernible breeding season, mating behavior having been observed whenever tidal and meteorological conditions permitted the observer to remain in the area for about 1½ hours after the tide turned.

No sexual selection seems apparent as far as the shell color of the individuals is concerned.

The size of sand grains in the habitat of a particular population may influence the size range, i.e., coarse sand prevents very small individuals from living there. In the search for food, *O. biplicata* does ingest sand.

During low tide *O. biplicata* becomes quiescent, tending to aggregate, sometimes in very large numbers, near larger rocks or kelpholdfasts; this quiescence is observed even in fairly large tide pools. With the return of the first cold waves, the animals resume active locomotion and travel surprisingly rapidly and far. This behavior is ascribed to a lack of oxygen rather than the influence of the tidal pressure.

The varieties *angelena* and *fucana*, established by Oldroyd, are considered of no taxonomic validity. The door is left open for the variety *parva*, described from Point Abreojos in Lower California, being possibly a valid geographical variant.

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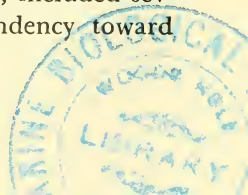
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NEW PHYLLONOTUS FROM THE EASTERN PACIFIC

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Having in recent years recommended the deletion of *Phyllonotus* (family Muricidae) from the roster of West American generic names, I now have the privilege of reinstating it, through a new discovery by an alert collector, Dr. Donald R. Shasky. To bring out the real significance of this find, one must review a little the history of the name *Phyllonotus* and its place in the Muricidae.

Phyllonotus Swainson, 1833, has, by convention, included several handsome muricid species that share a tendency toward



brown color banding, pink or brown coloration around the aperture, and heavy varices that are not firmly soldered to the whorl, especially near the suture. The number of these varices per whorl and their complexity of form are classificatory characters not usually regarded as important. A few years ago, with the revival of *Hexaplex* Perry, 1811,¹ complications began, for its type species would come within the boundaries of *Phyllonotus* in its customary sense. Nothing is gained, however, by synonymizing *Phyllonotus*. A possible way to preserve it would be to redefine both units; interestingly enough, a division could be made on the basis of morphology that would separate the species also into geographic groups. *Hexaplex*, with its East Indian type species and 3 West American forms—*H. brassica* (Lamarck, 1822), *H. erythrostomus* (Swainson, 1831), and *H. regius* (Swainson, 1821)²—would be restricted to the Pacific, whereas *Phyllonotus* would be entirely Atlantic in distribution. The type of *Phyllonotus* has usually been assumed to be the northern Caribbean *P. pomum* (Gmelin, 1791), for the actual monotypical type species, *P. imperialis* (Swainson, 1831) has been considered identical with it. Abbott (1958, p. 61) has challenged such a synonymy and, pointing out that the name *Murex imperialis* is a primary homonym, has renamed the type species as *M. (Phyllonotus) margaritensis*. His figures of the southern Caribbean form looked so disquietingly like *Hexaplex regius* that I speculated in print (Keen, 1959) on whether this might indeed be a Caribbean *Hexaplex*, in which case *Phyllonotus* as a name would be jeopardized more than ever. Opportunity since then to study several specimens and tabulation of all available size measurements have laid at rest my fears. I am con-

¹ *Hexaplex* was based on several species, none indicated as type. Jousseaume in the 1880's cited *Murex cichoreus* as type, but as this name was not actually in the original list, the first valid type selection was that of Hertlein and Strong, 1955: *H. foliacea* Perry = *Murex cichoreus* Gmelin, 1791 [better known under Lamarck's later name, *M. endivia*], an Indo-Pacific species.

² This specific name has been attributed to Wood, 1828, but I can now report that it was actually validated earlier by Swainson in his *Exotic Conchology*, ed. 1, pt. 2, October, 1821, in the caption to an unnumbered plate. The name was overlooked entirely by Sherborn in his *Index Animalium* (one of his rare omissions), although earlier Sherborn and Reynell (Proc. Malac. Soc. London, 11 (5): 279, 1915) had cited *Murex regius* as validated by Swainson. This earliest use of the name was confirmed when Dr. S. S. Berry acquired recently a copy of Swainson's exceedingly rare book.

vinced that *Phyllonotus margaritensis* is distinctive and not a *Hexaplex*. New limits, however, will have to be set for both groups, thus:

Hexaplex includes those shells with several varices (usually more than $4\frac{1}{2}$) per whorl, with well-developed frills and spines on the varices, especially along the shoulder of the whorl. Pink coloration of the aperture is characteristic in all species, from a trace of color at the posterior notch to complete suffusion of the entire aperture.

Phyllonotus comprises those shells with fewer than $4\frac{1}{2}$ varices (mostly 3 to $3\frac{1}{2}$) per whorl; varices have subdued spines or none at all. Pink coloration in the aperture is sporadic (i.e., in only one species and not invariably in that one).

Under the new arrangement, *Phyllonotus*, with *P. pomum*, *P. margaritensis* (or, as Dr. Clench [1959, p. 333] prefers, *P. pomum margaritensis*), and one or two West African species, would still be a group confined to the Atlantic were it not that a new and unquestionable eastern Pacific *Phyllonotus* has been found. Not only that, but the 8 specimens of the new form so far seen show sufficient morphologic and geographic differentiation to suggest a species and subspecies, which are here described.

PHYLLONOTUS Swainson, 1833

Zool. Illust., ser. 2, vol. 3, pl. 100 (generic name only, no species names cited).

Type species (subsequent fixation, Swainson, 1833): *Murex (Phyllonotus) imperialis*, var. a = *M. imperialis* Swainson, 1831 (not Fischer, 1807) = *M. (P.) margaritensis* Abbott, 1958 (new name).

PHYLLONOTUS PERATUS, new species. Pl. 10, fig. 6

Shell of medium size, with about 8 whorls, general color a dull grayish-brown, with obscure traces of underlying color bands of cinnamon to chestnut brown below the suture and on the base, with lighter areas between varices, and with darker spots on intervarical nodes; aperture white, suffused along the inner lip (also inside the outer lip of the holotype) with a warm creamy-yellow, and with four dark brown spots (ends of discontinuous color bands) showing on the outer lip, of which the uppermost spot continues above the aperture as a brown blotch. Sculpture of hollow spines along the varices, simulating

those of *Hexaplex* on a small scale, with 2 (rarely 3) axial rows of sharply-defined intervarical nodes. Varices regularly 3 per whorl, each varix ending just short of the corresponding varix of the previous whorl, so that the rows of varices run diagonally up the spire. Spiral sculpture of several primary cords (8 on the last whorl of the holotype) that show best near the varices and may disappear between the nodes, with 6 to 8 uniform-sized spiral threads both on and between the primary cords. Aperture somewhat elliptical, the inner lip nearly smooth, rising into a free-standing parietal wall; outer lip serrate, with 14 irregular notches that reflect the primary and some of the secondary spiral sculpture. Operculum dark brown, ovate, with the nucleus sub-terminal and the right margin thickened within; outer surface not smooth but showing a radial depression, marking the inner edge of the thickening, and about 11 undulating concentric increments of growth. Posterior siphonal notch of moderate size, angular. Anterior canal narrowed, markedly recurved, nearly closed. Remnants of previous canals present (one on holotype, two on paratype), projecting to the left of the pillar.

Dimensions: Holotype, length, 66 mm., width, 41 mm., length of aperture, 24 mm.; paratype, length, 69 mm., width, 42 mm., length of aperture, 25 mm.

Repositories: Holotype, California Academy of Sciences Paleo. Type Collection, no. 7780; paratype, no. 7780A.

Type locality: Calif. Acad. Sci. loc. 17974, 14 mi. SE of Judas Point, Costa Rica, depth 42 fathoms (T. Crocker-N.Y. Zool. Soc. Exped. Sta. 214-D-1, 9° 19' 32" N. Lat., 84° 29' 30" W. Long., Mar. 1, 1938; mud and shell bottom).³

Derivation of specific name: The Greeks had a word for this: their adjective *peratos* (transliteration), meaning, "on the opposite side, west." What more appropriate term could one ask?

Comparisons: Although some *Phyllonotus pomum* specimens are said to be spinose, none among the 40 available for comparison or among published illustrations equal *P. peratus* in this respect. Perhaps other specimens than the type lot of *P. peratus* lie, as they did in the California Academy's collection,

³ After this paper had been submitted for publication, I received a report from Mr. Martin D. Burkenroad that he had just got some peculiar specimens of a *Hexaplex*. My guess that they might be *Phyllonotus* proved correct. One of his 3 specimens, submitted for study, is a good *P. peratus* measuring 55 mm. in height, 36.5 mm. in diameter. The range of the species is therefore extended to Panama (trawled in 40 fathoms off Parita Bay, Gulf of Panama, Oct. 16, 1959). Relative proportions and sculpture of this specimen cast doubt on the validity of *P. p. decoris* as more than a color form, though again the southern specimen is slightly more spinose and darker in color than those from Mexico.

mislabelled "*Murex regius*, juvenile." The 3 varices and lack of pink coloration, of course, refute this.

PHYLLONOTUS PERATUS DECORIS, new subspecies. Pl. 10, figs. 4, 5, 7.

This may be only a color form, but the differences seem consistent. The aperture is brighter yellow than that of *P. peratus*, s. s., and the spire is a delicate coral pink for the first three or four whorls in some specimens. The untreated shell is lighter in color: a grayish-yellow. Etching with acid (which had happened to several specimens before they reached their present owners) reveals an underlying color pattern of bright cinnamon-brown bands on a white ground, with small flecks of darker and lighter brown to the left of each node between varices. Sculpture is lower and more subdued. The shell seems also a little smaller, with a shorter anterior canal and, in most specimens, a slightly shorter spire.

Dimensions in mm.

	Length	Width	Length of aperture
Holotype	59	38	22
Paratype	59	40	22
Hypotype 1	63	39	22
2	57	38	21
3	60	39	22
4	63	39	21

Repositories: Holotype, Stanford Univ. Paleo. Type Coll., no. 8753, courtesy of Dr. D. R. Shasky; Paratype, collection of Dr. Shasky; Hypotypes 1 to 3, collection of Captain Xavier Mendosa, Guaymas, Mexico; Hypotype 4, pl. 10, fig. 7, collection of Dr. Edwin J. Purcell, Tucson, Arizona, from west Mexico, exact locality and depth unknown.

Type locality: West Mexican coast near the Guatemalan border, depth about 15 fathoms; obtained from a shrimp boat by Dr. Donald R. Shasky.

Other localities: The hypotypes are also from shrimp boats—exact localities unknown but unquestionably from the West Mexican coast between the Gulf of Tehuantepec and Guaymas, Sonora, probably in the Salina Cruz area, all taken in nets of the Hector II, Cpt. Juan Rios, skipper.

Derivation of name: The adjective *decoris* is a Latin word meaning "elegant", "ornamented", or "beautiful", all appropriate terms for this shell.

Comparisons: The distinctions between *P. peratus peratus* and *P. peratus decoris*, though slight, are apparently consistent, the

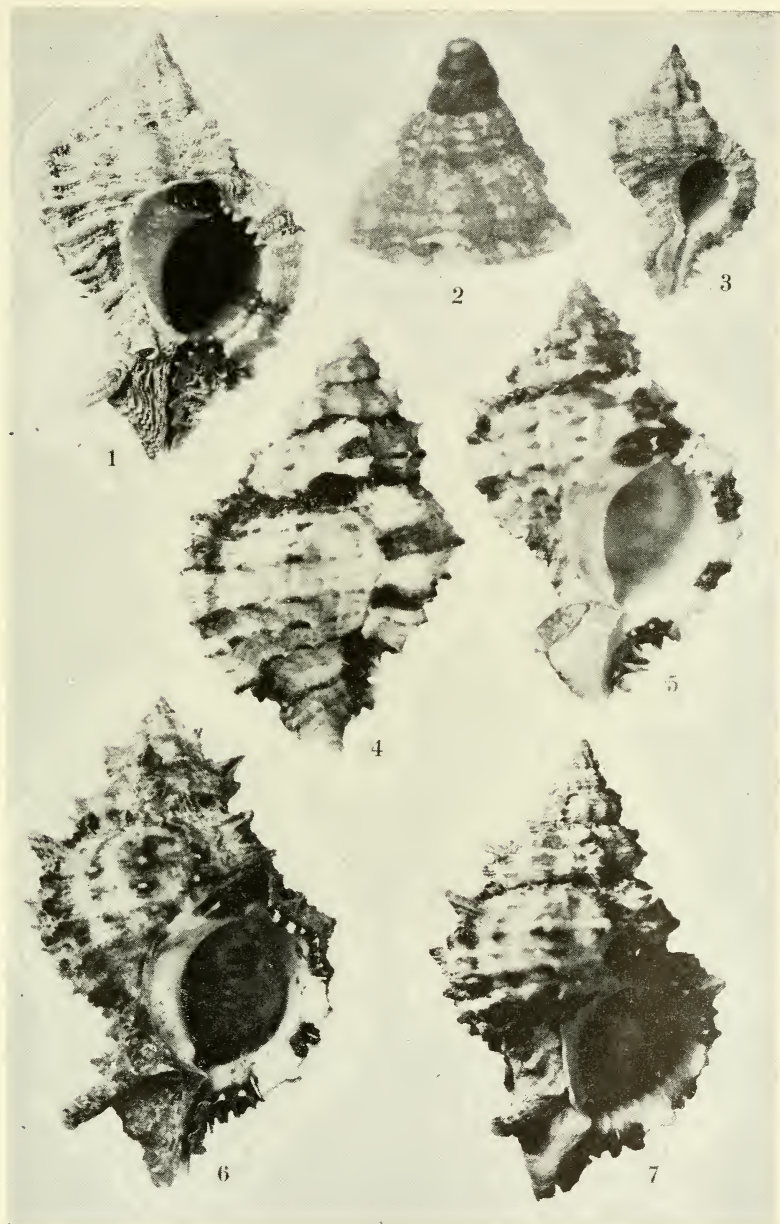
dimensions of the 6 specimens of the latter being almost identical except for the one slender variant shown in fig. 7. *P. peratus*, s. s., geographically a more southern form, seems to be somewhat the larger, with a higher spire and longer canal. Differences of both from *P. pomum* may be summarized thus: In *P. pomum* the varices become narrowed at the suture, giving the effect of being tucked under the preceding varix, whereas in *P. peratus*, s. l., they tend to flare and in *P. peratus*, s. s., to form several imbricating scales or laminae. In *P. pomum* the spiral sculpture consists of alternating primary and secondary ribs, striated by finer threads. In *P. peratus* the secondary sculpture is nearly even, with no additional fine threads. In *P. pomum* the intervarical spaces rise into one or two rounded axial ribs, but in *P. peratus* there are only isolated and sharp-pointed nodes in irregular rows. Graphical analysis of height-width ratios shows that although *P. pomum* is more variable, *P. peratus* tends to be longer for the width, to have a larger aperture, and to have a narrower canal.

Phyllonotus pomum seems to be a stock in which geographic races are developing into possible subspecies. The southern Caribbean stock, here regarded, for convenience, as a separate species (*P. margaritensis*), seems, on the basis of 9 specimens for which measurements were available (as compared to 18, chosen as random, for *P. pomum*), to grow much larger (maximum length 110 mm., as compared to 85 in *P. pomum*), and it is markedly wider for the length, with a larger aperture and a wider canal. One unnamed variant of *P. pomum*, represented in the Stanford Collection by 3 specimens from Colon, Panama, is nearly as spinous as *P. peratus*, but the shells are decidedly thinner and more slender, darker in color (almost a uniform chestnut brown in one specimen), with a much longer and nearly straight anterior canal. All these variations imply that the Miocene ancestor of the tropical-American *Phyllonotus* stock was a vigorous strain capable of a number of geographic variations that are now being realized in both the western Atlantic and the eastern Pacific.

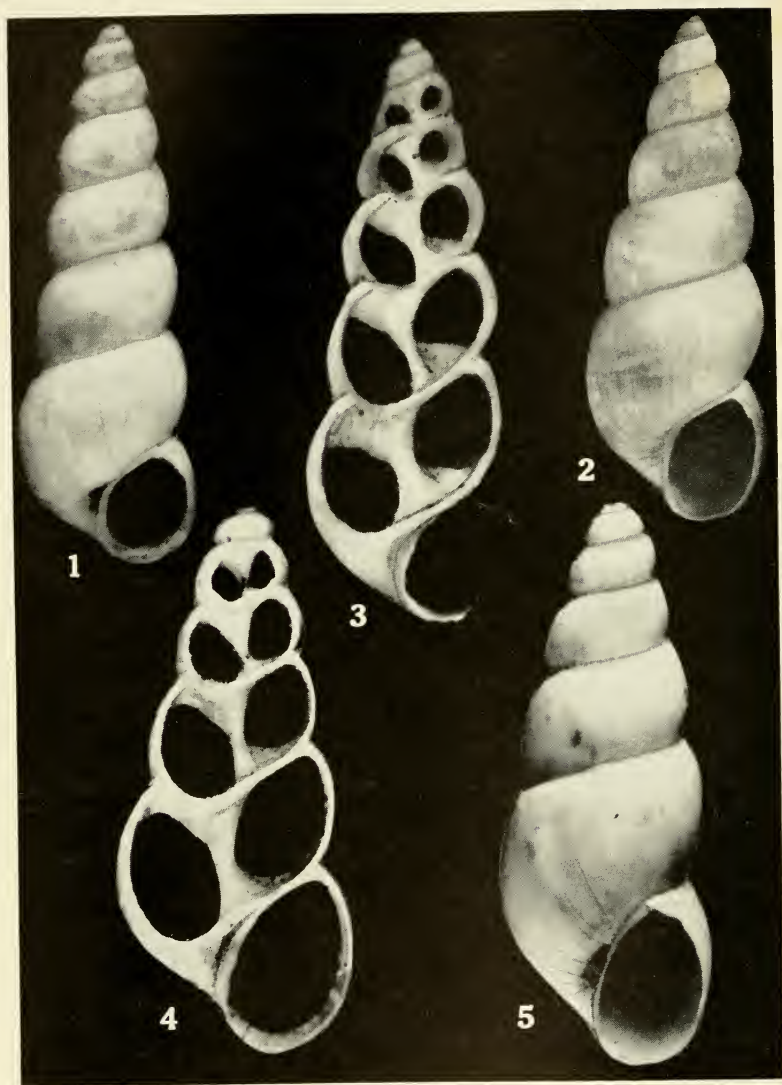
PHYLLONOTUS SP.

Pl. 10, figs. 2-3

A single specimen of a form that one would assume should be



1 ($\times 1$), *Phyllonotus pomum* (Gmelin), Grand Bahama I., James McLean. coll. 2 ($\times 9$) and 3 ($\times 1$), *P. sp.* 4, 5 ($\times 1$), *P. peratus decoris* Keen, holotype. 6 ($\times 1$), *P. peratus* Keen, holotype. 7 ($\times 1$), *P. peratus decoris* Keen, hypotype 4.



1-3, *Calipyrghula pecosensis* Leonard and Ho (1, holotype, 11265, KUMNH. 2, paratype, 11266 KUMNH. having 7 whorls and proportions approaching *C. hibbardi*. 3, paratype, 11266, KUMNH., sectioned to show strongly twisted columella). 4, 5, *C. hibbardi* Leonard and Franzen, paratypes, 981, KUMNH., from Lower Pliocene Laverne Formation, $5\frac{1}{2}$ miles south Gate, Beaver County, Okla. (4, sectioned to show nature of columella). All figures enlarged approximately 15 times.

part of the *P. peratus* complex was collected by Mr. E. C. Stiles on the beach at Mazatlán, Mexico. The specimen, although not taken alive, was but recently dead, for the nuclear tip is complete and perfect, showing $2\frac{1}{2}$ dark brown, rather cylindrical, smooth whorls above the cancellate juvenile shell. Having only 6 whorls, the specimen is evidently immature. Careful study of sculpture, form of varices, and other criteria that separate *P. peratus* from its congeners leaves one with the conviction that this is a specimen of *P. pomum*. It is figured here for two reasons: to show the form of the nuclear whorls, of which I have seen no good illustration, and to put collectors at Mazatlán on the alert. Though this seems unlikely, one must not dismiss as impossible the survival of *P. pomum* in both oceans since the separation of the Atlantic and the Pacific during the later part of the Tertiary. Fortuitous introduction of this specimen to the Mazatlán beach seems more probable, however, perhaps by shell-collecting tourists who had recently been working the shores of eastern Mexico.

Repository: Stanford Univ. Paleo. Type Coll., no. 8754, courtesy of Mr. E. C. Stiles, collector. Mazatlán, Mexico, spring, 1958.

Acknowledgments. My special thanks go to the collectors whose loan and gift of material made this paper possible: Dr. Donald R. Shasky, of Glendale, California; Dr. Edwin J. Purcell, of Tucson, Arizona; Mr. Everett C. Stiles, of Seattle, Washington, and the California Academy of Sciences, San Francisco. I wish to thank Dr. William Clench for a comparative specimen of *P. margaritensis*, Mr. and Mrs. John Q. Burch for the privilege of studying their holdings of this form, and Mr. James McLean for the loan of an unusually fine specimen of *P. pomum* for illustration.

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A NEW SPECIES OF CALIPYRGULA (HYDROBIIDAE) FROM THE PLEISTOCENE OF TEXAS

BY A. BYRON LEONARD AND TONG-YUN HO

In the course of studies on the fossil molluscan faunas in the late Cenozoic continental deposits of western and southwestern Texas, sponsored jointly by the University of Texas Bureau of Economic Geology, and The National Science Foundation under the terms of a contract (NSF-G3481) between National Science Foundation and the University of Kansas, shells of an undescribed species of hydrobiid gastropod in late Pleistocene deposits in the Pecos River Valley were discovered.

The new species is assigned to the genus *Calipyrgula* Pilsbry, because of the general resemblance to other species now assigned to that genus, and the great difficulty of establishing actual relationships among hydrobiid snails in the absence of the soft parts. There is no proof that the species described by Leonard and Franzen (1944, p. 19) from the early Pliocene Laverne Formation are in fact congeneric with those described by Pilsbry (1934, p. 541) or that the species under consideration here is congeneric with either of the two previously described groups of species assigned to the genus *Calipyrgula*. Admitting the widely separated localities of occurrence and considerations of stratigraphic occurrence (Leonard and Franzen, 1944; Pilsbry, 1955), it seems unlikely that all these species are actually congeneric, but there seems little to be gained by proposing generic names for the species concerned.

CALIPYRGULA PECOSENSIS, new species. Plate 11, figs. 1-3.

Diagnosis: A minute hydrobiid gastropod, having an elongate, narrowly conic, imperforate or narrowly rimate shell of 7 or 8 rounded whorls; small aperture; simple, ovate peristome, reflected over umbilicus and adherent to last whorl above; simple and well incised suture.

Calipyrgula pecosensis (pl. 11, figs. 1-3) most closely resembles *C. hibbardi* Leonard and Franzen, (figs. 4, 5) but differs in having a more slender shell, one or two more whorls, less elongately oval aperture (figs. 1, 2, 5) and more strongly twisted and slightly heavier columellar axis (figs. 3, 4).

Holotype: Catalogue number 11265, University of Kansas Museum of Natural History, obtained by A. B. Leonard and

Tong-Yun Ho, 6 June 1959. Original number, ABL 1012A.

Description of holotype: Shell elongately conic, imperforate, small (total length, 4.42 mm., diameter, 1.27 mm.), last whorl relatively large, comprising approximately one-half the total length of shell; spire narrow, slender, tapering gradually to relatively blunt apex; aperture ovate, higher than wide (height, 0.97 mm., diameter 0.71 mm.); peristome simple, inner margin reflected over umbilicus, and closely adherent to last whorl above; whorls 8, well rounded at periphery; suture simple, deeply incised; one and one-half apical whorls finely granulate having waxy texture, remaining whorls having closely spaced, delicate, vertical growth ridges not clearly visible without magnification, and extremely delicate incised spiral grooves, visible only with high magnification.

Paratypes: Little variation occurs among the more than 1000 paratypes collected from 6 localities, although a few individuals (Pl. 11, fig. 2), are less narrowly elongate than is the holotype and have proportions that more nearly approach those of *Calipyrghula hibbardi*. The extremes of variation are exemplified by the measurements (in millimeters) of 4 paratypes (catalogue number, 11266) from the type locality.

Total length	Diameter	Height Aperture	Diameter Aperture	No. of whorls
4.80	1.32	0.97	0.73	8
4.80	1.50	0.97	0.75	8
4.20	1.57	1.05	1.05	7
3.97	1.50	1.05	0.75	7

On a few paratypical shells, the fine, incised spiral sculpture is somewhat better developed, especially on the last whorl, than on the holotype, but on none is the sculpture a conspicuous feature. Rarely, individual shells possess irregularly distributed, strong, vertical ridges, seemingly produced by fusion of the usual, fine, more numerous vertical ridges. Still other rare specimens have the peristome erect, not reflected over the minute umbilicus, and standing free of the last whorl above. Paratypical specimens have been deposited at the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts.

Type locality: Late Pleistocene deposits exposed in left bank of Pecos River, 3.5 miles northeast of Imperial, in Crane County, Texas.

Stratigraphic distribution: Each of the six collecting localities from which *Calipyrghula pecosensis* has been recovered consists of late Pleistocene terrace deposits, exposed by subsequent degra-

dation of the channel of the Pecos River. If *C. pecosensis* is biologically congeneric with *C. hibbardi*, of the early Pliocene Laverne Formation of northwestern Oklahoma (Leonard and Franzen, 1944, p. 19), the genus is unaccounted for in the region of its known occurrence east of the Rocky Mountains, through most of late Cenozoic time.

Areal distribution and ecology: *Calipyrgula pecosensis* is now known only from exposures along the Pecos River, southwestern Texas, distributed from Pecos River at bridge on U. S. Highway 290, 3 miles southeast of Sheffield, Pecos County, to one mile east of the city of Pecos, in Ward County. Although the latter locality provided the most abundant population of all the local deposits from which the species was collected, we were unable to discover examples farther upstream.

The 6 localities from which *C. pecosensis* was collected, together with approximate numbers of specimens taken at each locality, are:

Right bank of Pecos River, near bridge on U. S. Highway 290, 3 miles southeast of Sheffield, Pecos County, Texas; 5 specimens.

Right bank of Pecos River, 5 miles northeast of Buena Vista, Pecos County, Texas; 50 specimens.

Left bank of Pecos River, 3.5 miles northeast of Imperial, in Crane County, Texas; 400 specimens. (Type locality.)

Left bank of Pecos River, 3 miles northwest of Imperial, in Crane County, Texas; 300 specimens.

Left bank of Pecos River, 3 miles southwest of Grand Falls, Ward County, Texas; 250 specimens.

Left bank of Pecos River, one mile east of Pecos, in Ward County, Texas; 350 specimens.

Little is known of the ecological requirements of *Calipyrgula pecosensis*. Judging from the lithology of the sediments in which it has been found (finely and well sorted silts and fine sand, having humic stains and marl development), this snail thrived in sluggish streams or in marshes; this view is strengthened by the occurrence with it of numerous individuals of *Physa anatina*, *Ferrissia parallela*, *Pisidium* sp., and a species of ostracod. So far as known, however, no other prosobranchiate gastropod occurs with *C. pecosensis*.

LITERATURE CITED

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Pilsbry, Henry A. 1935. Mollusks of the fresh-water Pliocene beds of the Kettleman Hills and neighboring oil fields, California. Proc. Acad. Nat. Sci. Philadelphia 86: 541-570, Jan. 29 (issue of 1934)

SUCCINEA AUREA LEA AND S. PYRITES, NEW

By LESLIE HUBRICHT

Succinea aurea was described by Lea (Proc. Amer. Philos. Soc. 2:32, 1841. Trans. Amer. Philos. Soc. 9:4, 1846) from specimens collected at Springfield, Ohio. During the spring of 1958, the author visited Springfield to collect this species. Two species of Succineidae, *Oxyloma retusa* (Lea) and *Quickella vermeta* (Say), were found in abundance in that area.

In his description, Lea states: "This is a beautiful little species, remarkable for its fine surface and bright golden colour. In form it is nearly allied to *vermeta*. (Say.)" *Quickella vermeta* is sometimes of a bright golden color, especially when it lives in sunny situations. *Succinea aurea* is undoubtedly based on *Quickella vermeta*, and the Atlantic Coastal species which has borne this name is a different species.

For this Atlantic Coastal species, the author proposes the name *Succinea pyrites*, new species. It is described by H. A. Pilsbry, Land Mollusca of North America (North of Mexico) 2:815-818, figs. 441a, b; 442E (holotype), F. Type locality: Cape May, New Jersey, holotype 67795, paratypes 247364 & 189420 A.N.S.P., other paratypes 20614, collection of the author.

Of the localities cited by Pilsbry for *Succinea aurea*, those from near the Atlantic Coast from Virginia to New Jersey are probably all *Succinea pyrites*. In the authors experience, *S. pyrites* is confined to salt marshes and the records from western New York need to be verified anatomically before being accepted. The records from Yammasee, South Carolina; Wells, York Co., Maine; and Barnstable Co., Massachusetts, are based on immature shells which are unidentifiable. The record from Oldtown, Ohio, is based on an immature specimen of *Oxyloma retusa* (Lea). The records from Cincinnati, Ohio, and Clark Co., Indiana, are undoubtedly based on *Quickella vermeta* which is a very common snail along the Ohio River.

THE GREEN LAND MOLLUSK FROM NEW GUINEA

BY WILLIAM J. CLENCH

Mr. J. B. Henrard (Naut. 73: 63-65, 1959) has questioned the generic placement of the species I described as *Eustomopsis* (*Verdichloritis*) *polingi*. He claims that it should be *Planispira* (*Cristigibba*) *polingi*. As he has not seen my specimen of *polingi*, his specimens may be something else, as *polingi* is not, in any sense, a *Cristigibba* and certainly is a "*Chloritis*". The few specimens of three species of *Cristigibba* in the MCZ. are comparatively heavy shells, are opaque, and possess a very strong gibbous crest. *E. polingi* is thin, translucent and has no trace of a crest. It does have a very slight depression behind the lip, a character found in a multitude of land mollusks.

The shell morphology is that of *Eustomopsis*, but its final placement in this genus must await the time when its soft anatomy is known.

Regarding the green coloration exhibited by a few genera of land mollusks, I did not raise the question as to whether this color was impregnated in the lime of the shell or only invested in the periostracum. Henrard's statement that "in all those shells, (i.e. *Liguus*, *Amphidromus*) the coloring matter is situated in the calcareous layer of the whorls and all the other shells mentioned by him", is certainly in error. The green color in *Liguus*, most *Amphidromus*, *Helicostyla*, *Papuina* and others, is located in the periostracum.

FAMILY NAMES IN PULMONATA, 4

BY H. BURRINGTON BAKER

The following alphabetic index to the subfamilies and synonyms of the family names in Pulmonata gives each combining stem and, after a hyphen, enough letters to place the family in the alphabetic list in my first (1) paper, Naut. 69:128, which was supplemented by a second (2), Naut. 70:34, and a third (3), Naut. 70:141. This is the 4th. In these supplements, the names in the first were corrected or redated (Cf. 2, 3, or 4) and more names were added (2, 3 or 4). The families with synonyms are followed by CAPITAL letters, to assist in recognition of their abbreviations.

At the London Congress (1958): "The rule that a family name is not to be changed when the type genus is found to be a synonym" (Cf. 1, footnotes 2 & 4) "was reaffirmed, with the clear provision that this was not intended to upset changes of long standing or wide acceptance" (News letter, Soc. Syst. Zool., ser. 2, no. 9, p. 2). Will not the application of this "clear" provision and/or the "50 year rule" be very difficult? In any case, please do not quote my 4 lists for the "acceptance" of any of the changes involved. The family names which are based on synonyms are Aperidae, Auriculidae (?), Buliminidae, Cochlostylidae (obsolete) or Eulotidae, Gadiniidae, Helicterinae (Achatinellidae) and Lucerninae (Camaenidae). The last two apparently have been in synonymy for 50 years, as is also true of any name founded on *Brachypodella* (Urocoptidae), Mesodontinae (Polygyridae) or *Scolodens* (Scolodontidae or Systrophidae), and probably Plectopylididae (Corillidae). Nevertheless, "Helicteridae" was used as a heading in the Zoological Record until 1939.

Acanthinul-Va.¹ Acav-ACA (cf. 3). Acell-Ly. Achatin-ACH. Achatinell-Helict. Acrolox-An.¹ Acrob-ini Starabogatov (1958)-Pl. Acrore- (cf. 3). Adven-Eu. Aegist-Eul (cf. 2). Agriolimac-Li. Ailly-. Albe-Hy (3). Alop-Cl. Amastr-AMA. Ameriann-eae Zilch (1959)-Pl. Ammonitell-Thys., Lu. Amphibol-AMP.¹ Amphibulim-Or. Amphidox-Pun. Amphidrom-Lu. Amphipepl-Ly. Ampull-Ach (3). Ampullacer-Amp. Anaden-Ar. Ancyl-AN (cf. 3).¹ Ancylostr-An.¹ Aneite-At. Anoglypt-Aca (3) Anthracopu-pinae Zilch (1959)-Au. Aper-AP. Aqueban-Sa. Ariant-He.¹ Ariolimac-Ar. Arion-AR.¹ Ariophant-Xe. Artemon-Str. (3). Aspasit-Va. Athoracophor-AT. Aulacospirinae Zilch (1959)-Pup. Auricul-AU (cf. 2). Auriculell-To. Austroselenit-Str. Azec-idae¹ Kennard & Woodward (1926)-Ci.

Bale-Cl.¹ Berendti-Br. Binney-Ar. Biomphalari-Pl. Bothiembry-Or (3). Brachypodell-BR (= Urocoptidae). Bradybaeninae Pilsbry (1924)-Eul. Bulim.² Bulimin-BU. Buliminops-Eul. Bulimul-Or. Bulin- (cf. 3, but correct "Bulinulinae" to Bulininae) Bullin-Pl (cf. 3).

Caecili-Ach. Caecilianell-Ach. Camaen-Lu. Camptocerat-Pl. Campylae-He. Carychi-CA.¹ Caryod-Aca. Cassidul-Au (cf. 3). Catinnell-Su. Cecilioid-Ach.¹ Cepol-, Cepoli-Xa (cf. 3). Cerast-Bu. Cerastuinae Wenz (1930)-Bu. Ceri-, Cerion-CE (cf. 3).¹

¹ "Type genus" accepted by ICZN. *Ancylus* takes as type *A. fluviatilis*, so Pseudancylinae is a synonym of Ancylinae, and Acroloxinae replaces my (1) typical subfamily.

- Charop-Pun. Chilin-. Chlamydephor-Ap. Chlorit-Lu. Choa-nomphal-Pl. Chondrin-Bu, Pup. Chondrul-Bu. Chron-Eu. Cionell-Cl. Circinari-Va, Ha. Clausili-CL.¹ Clavator-Aca. Cochlicop-Ol, Ci. Cochlodin-Cl. Cochlostyl-Eul (3), but prior (obsolete?). Coeliox-Ach (cf. 3) Coneuplect-Eu (3). Conovul-Au. Conul-Eu.² Coret-Pl. Corill-Ple. Cryptelasm-Ach. Cryptell-Li. Cylindrell-Br. Cystopelt-Eu.
- Daudebardi-Vi. Derocerat-Li (3). Dipnelic-Lu (2). Disc-Pun.¹ Dorcasi- (cf. 3). Drepanotrem (at)-cae Zilch (1959) -Pl. Durgell-Xe. Durgellin-Eu (cf. 3). Dyak-Xe.
- Elasmatin-To. Ellobi-Au. En-Bu (cf. 2).¹ Endodont-Pun. Enne-Str (cf. 3). Epiphragmophor-Xa. Erept-Helica (cf. 2). Euca-lod-Br. Euconul-EU.¹ Euglandin-Sp. Eulot-EUL (cf. 3). Eu-paryph-He.²
- Fanul-Eu. Ferrissi-An. Ferussac-Ach. Filholi-Cl. Flammulin-Pun (cf. 3). Fruticicol-Eul, Hy. Fusul-Cl.
- Gadini-G (cf. 3). Garnieri-Cl (cf. 3). Gastrocopt-Pup. Gastro-dont-Vi. Geomitr-Hy. Geotroch-Helica. Gibb-Str. (2). Girasi-Xe (cf. 3). Glandin-Ol. Godwini-Vi. Gonidom-Str (2). Gonio-disc-Pun. Grangerell-Or. Gudeconch-Pun.
- Hadr-Lu. Haplotremat-HA. Hedleyell-Aca. Hedleyoconch-Eu. Helic-HE.¹ Helicarion-HELICA (cf. 3; Helixarionidae prior). Helicell-Vi,² Hy (cf. 3),¹ He.² Helicigon-He (cf. 3). Helicodisc-Pun. Helicodont-He (cf. 3). Helicostyl-Eul (cf. 3). Helicter-HELICT (= Achatinellidae). Helisomat-Pl. Helixarion-Helica (3). Helminthoglypt-Xa. Hemiplect-Xe. Holospir-Br. Humboldtian-Xa. Hyalimac-Su. Hyalini-Vi. Hygromi-HY.¹ Hypselostomat-inae Zilch (1959) -Pup.
- Imer-Va. Isidor-Pl.
- Jacost-Hy.² Jamini-Bu. Janell-At. Janul-Vi.
- Kaliell-Helica.
- Laevapic-An. Laminifer-Cl. Lampadi-Lu (3). Lanc.- Laom-Pun. Lati- (cf. 3). Lauri-Pup.¹ Ledoulxi-Ur. Leptachatin-Ama. Leptax-He. Leucochro-Hy. Liardeti-Eu. Ligu-Or (2). Limac-LI (cf. 3).¹ Limn-, Limnae-Ly.² Limnophys-Ly. Lucern-LU (= Camaenidae). Lymn-,² Lymnae-LY (cf. 2).¹ Lysino-Xa.
- Macrochlamyd-Xe. Macrocyll-. Marpess-Cl. Megalophaedus-Cl (3). Megaspir-. Megomphic-Thys., Lu. Meisenheimeri-Va. Melamp-Au. Mantissoide-Cl. Mesodont-MES (= Polygyridae). Microceram-Br. Microcyst-Eu. Milac-Li.¹ Miratest-Pl (3). Murell-He (cf. 3). Myotest-Xe.
- Nanin-Xe. Napae-Bu. Neni-, Neniast-Cl. Neoplanorb-An. Neso-pup-Pup. Nitor-Helica.
- Obelisc-Ach (cf. 3). Odontostom-Or. Oleacin-OL.¹ Onchid-, Oncidi-ON. Oncidiell-On. Oopelt-Ar. Opeat-Ach. Orcul-Pup.

² "Type genus" rejected by ICZN.

- Oreohelic-Lu. Orthalic-OR. Orthogibb-Str (2). Ostracoleth-Xe. Otin-¹ Otoconch-Pun.
- Pachnod-Bu. Pacificell-To. Pagodin-, Pagodul-, Pagodulin-Pup. Papuin-Lu. Paralaom-Pun. Parmacell-Li. Parmacellill-Tr. Parmarion-Xe. Partul-. Paryphant-Rh (cf. 3 & 2). Patul-Pun. Patulastr-Pun. Pedinogy-Aca. Pediped-Au. Peltat-Ur. Peroni-On. Phaesus-Cl. Phenacohelic-Pun. Philomyc-PHI. Philonesi-Eu. Phys-. Physastr-inae Starabogatov (1958)-Pl. Planispir-Lu. Planorb-PL (cf. 3).¹ Planorbul-Pl. Platysuccine-Sa. Plectopylid-PLE (cf. 3; = Corillidae). Plesiophys-inae Bequaert & Clench (1939)-Pl. Pleurodisc-PLEU (= Pyramidulidae,¹ 1914). Pleurodont-Lu. Plutoni-Vi. Poecilozonit-Vi. Polygyr-Mes. Polygyrell-Thys. Pompholic-Pl. Pompholycode-Pl. Protancyl-Pl. Pseudancyl-An.² Pseudocharop-Pun. Pseudoplect-Xe. Pseudotrochatell-Helica. Pseudoveronicell-Va. Ptychotre-mat-Str. Punct-PUN.¹ Pup-Ce (cf. 3). Pupill-PUP.¹ Pyramidul-idae¹ Kennard & Woodward (1914)-Pleu. Pythi-Au.
- Rathousi- (cf. 3) Rhagad-Lu. Rhodacm-An. Rhytid-RH (cf. 3). Rotadisc-Pun. Rumin-Ach.¹
- Sagd-SA. Sarasinul-Ve. Scalax-inae Zilch (1959)-Ach. Scaph-On. Scarab-Au. Scolodent-, Scolodont-SC. Segmentin-Pl.¹ Selenit-Str. Semperul-Ve. Serrul-Cl (3). Sesar-Helica. Sheldoni-Ur. Siphonari-. Sital-Xe. Sonorell-Xa. Sophin-Eu. Spelaeoconch-Ci. Spelaeodisc-Va. Sphincterochil-inae Wenz (1959)-Hy. Spirax-SP. Staffordi-Xe. Stenacm- (cf. Naut. 72:68). Stenogy-Ach. Stenop-Sc. Stenopyl-Pun. Streptax-STR. Strepotel-Str (3). Streptostyl-Sp. Strobil-, Strobilops- STRO. Strobil-idae Zilch (1959) not Joos (1911)-To. Succinea-SU³. Systrophi-Sc.
- Tacheocampylae-He (3). Tanychlamyd-Xe. Tebennophor-Phi. Testacell- Theb-He.¹ Thyrophorell- (cf. 3). Thysanophor-THYS. Thysanot-Pun. Tornatellin-TO.¹ Trigonochlamyd-TR. Triodops-Mes. Trimuscul-idae Habe (1958)-G. Triptychi-Cl. Trochomorph-Vi. Trochananin-Ur. Eu. Trochozonit-Ur. Troch-Hy. Truncatellin-Pup.¹
- Urocopt-Br. Urocyl-UR.
- Vaginul-Ve. Vallon-VA.¹ Varicell-Ol. Veronicell-VE. Vertigin-Pup.¹ Vitre-Vi.¹ Vitrin-VI. Vitriplutoni-, Vitri-niplutoni-Vi.
- Xanthomelon-Lu. Xanthonych-XA. Xerophil-He, Hy.² Xest-XE.
- Zacole-inae Webb (1959)-Ar. Zaptych-Cl (3; Xaptych-). Zonit-Vi. Zosph-Str. Zospe-idae Bourguignat (1856)-Ca.

³ Previously (1), I did not notice that *succinea* was a Latin adjective.

NOTES AND NEWS

LLOYD E. BERRY, 1892-1959.—On October the sixth, 1959, we

lost a very dear and true friend with the passing of Lloyd E. Berry, a retired U. S. Army lieutenant who saw action in Siberia during World War I. His passing at the U. S. Government Hospital at Sawtelle was the result of service-connected disability. We who have known Mr. Berry the last decade knew him as a conchologist, who specialized on the Cypraeidae, having an outstanding collection. Few *Cypraea* collectors could equal his collection in quality, number of species, and number of specimens. Nor do I know of a private collection that was so well kept. This fabulous collection was inherited by his surviving sister, Mrs. J. V. Yankie, 1804 Warwick Road, San Marino, California, and will eventually be for sale as a unit.—Mrs. JOHN Q. BURCH

SANIBEL MARINES.—I understand that some Indo-Pacific shells are being found on Sanibel Island, Florida, and think that this is the result of dredging. Some 3 shell collections were lost during a hurricane in 1920, and now these shells are being found on the beach, dead, of course.—LULA B. SIEKMAN (from letter).

SINISTRAL SHELL OF *CAMPELOMA INTEGRUM*.—While sinistral specimens of the uterine young of *Campeloma* are fairly common, adult specimens of reversed symmetry are only rarely collected. An adult sinistral specimen of *Campeloma integrum* Say was collected by one of my students in field zoology, Mario Pisanelli, on April 8, 1959. This shell and three dextral shells of the same species were collected in a swamp at Twin Lakes, north of Kent, Ohio. The sinistral shell measures 30 mm. high, and 19 mm. wide. The apex is eroded, and $4\frac{1}{2}$ whorls are in view. The species was determined by Dr. William J. Clench, and the specimen was given to the Museum of Comparative Zoology at Cambridge, Mass.

Over (Naut. 29: 90-95. 1915) reported a similar sinistral specimen of this species from the Vermilion River in Clay County, South Dakota. Sinistral specimens of *C. decisum* have been reported by Ancey from New York (Naut. 10: 104-105. 1897), Hinkley (Naut. 20: 40-44. 1906) from the Tennessee River, Vanatta (Naut. 26: 96. 1912) from Pennsylvania, and Daniels (Naut. 26: 38-42. 1912) from Indiana. F. C. Baker (The Fresh-water Mollusca of Wisconsin, Part I, p. 67. 1928) reported one

reversed specimen among 160 adults collected. Sinistral shells of *C. subsolidum* were found in Missouri by Sampson (Naut. 29: 128-129. 1916) and one of *C. geniculum* by Goodrich (Naut. 52: 129-131. 1939) in Georgia. Webb (United States Mollusca, p. 149. 1942) gives an illustration of a sinistral specimen of *C. ponderosa* and *C. decisum*, the latter from New York. Sinistral specimens of an unidentified species of *Campeloma* were described by Hand (Naut. 41: 106-107. 1928) and by Meyer (Naut. 41: 107. 1928) from Chicago. Pilsbry (Naut. 10: 118. 1897) commented in regard to the rarity of reversed adult shells of *Campeloma* that, "This doubtless indicates that the reversed condition is an unfavorable one for maturation."—RALPH W. DEXTER, Dept. of Biology, Kent State Univ., Kent, Ohio.

PUBLICATIONS RECEIVED

EUTHYNEURA. By Adolf Zilch. Handbuch der Palaeozoologie. Gastropoda, by Wilhelm Wenz, continued Teil 2, Lieferung 1, pp. 1-200 + I-XII, 701 figs. 1959.—This issue carefully surveys the shell-bearing (fossil forming) opisthobranchs and Pulmonata, up through the geophile Orthurethra and Heterurethra. For each genus or subgenus included, the type species, a brief description of its shell, and its distribution in time and space, are given. Shell descriptions for the major taxons are necessarily vague, and notes on the animals, about which little can be learned from paleozoology, mainly are limited to habitat and external form. The figures of the type species show the shape excellently, but sometimes are a little weak on details, such as sculpture and apertural armatures. However, they do serve well to illustrate this systematic outline, which, of course, is not meant to be used for specific identifications. In the limnophiles, the Lincinae are included in the Lymnaeidae, but the Ancyliidae are divided into 5 families. Among the last is the "Ferrissiidae," although unfortunately Hannibal, 1912, made both Laevapicinae and its "type genus" prior. In the pupilloids, Steenberg, 1925, is followed mainly. Of course, his "Chondrinidae" is subsequent to Gastrocoptinae Pilsbry, 1918, and even the usage of *Chondrina* is open to doubt (Cf. Pilsbry, 1935, Man. Conch. 28:203). In general, the names of familial groups follow the old "rules;" for example, "Trimusculidae" is substituted for Gadiniidae,

1840. On the other hand, "Cerastuinae" apparently is preferred to Pachnodinae because of the supposed homonymy (?) of the "type genus" of Cerastinae Wenz, 1923. Subclass Euthyneura is divided into 10 orders, 6 or 7 of which are opisthobranchs ("Suborder" Notaspidea, p. 59) and 2 or 3 are Pulmonata (Soleolifera omitted, p. 4). To the latter, I would add Actophila (p. 63) and Thalossophila (Amphibolidae & Siphonariidae, but not Gadiniidae, which are patelliform Limnophila).—H. B. B. GEBRUDER BORNTAEGER, Berlin. DM 84.

TWO NEW PLEUROCERID snails from eastern Mexico. By Fred G. Thompson. Occ. Papers Mus. Zool. Univ. Mich. 600: 8 pp., 1 fig., 1 pl. 1959.—*Lithasiopsis crassa* and *L. darnelli* are described from Rio Sabinas. Radulae are like northern genera.—H. B. B.

"TAPHIUS PRONUS" (Martens, 1873) Pulmonata, Planorbidae). By W. Lobato Paraense & Newton Deslandes. Rev. Brazil. Biol. 18:367-373, 10 figs. 1958.—Shells and animals are described and figured clearly.—H. B. B.

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SEVEN PUERTO RICO CONES: NOTES AND RADULAE

By GERMAINE L. WARMKE

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The cones are among the most beautiful and most interesting gastropod mollusks. At least part of this interest comes from the fact that they possess a poison gland and are capable of injecting a venom into their prey by means of detachable, spear-like radula teeth (p. 123). Painful and even fatal bites are reported to have been inflicted on humans (Abbott, 1950). None of the West Indian species, however, is believed to be dangerous to man.

The present paper describes the radulae of seven species of cones found in Puerto Rico. Most of these species occur throughout the West Indies; but to our knowledge, the radulae have not been described or figured previously.

All the radulae studied are toxoglossate. Each tooth is made up of a sheet of chitin rolled up like a paper spill. The teeth, from 20 to 70 in number, depending on the species, are enclosed in a radula sac. These are detached one at a time from the radula, through the proboscis, to paralyze the prey. A highly toxic venom flows from the large poison gland through the hollow tube of the tooth when the tooth is emitted by the animal.

The radula teeth studied appear to fall into four distinct groups, as follows:

1. Point armed on one side with a barb and on the other with a blunt-ended blade. (fig. 4). The tooth is serrate for about half of its length. There is usually a minute cusp at the end of the serration. In addition, there is a spur at the base of the tooth. *C. daucus*, *C. spurius*, *C. mus*, and *C. juliae* belong to this group. These four species can easily be separated by the following key:
 - A. Serration just over $\frac{1}{2}$ length of tooth. Blade very short *C. spurius* (fig. 5)
 - B. Serration less than $\frac{1}{2}$ length of tooth.
 1. Blade slightly longer than serration, serration usually with 17-22 notches *C. juliae* (fig. 6)
 2. Blade shorter than serration.
 - a. Blade about $\frac{1}{2}$ length of serration *C. daucus* (fig. 4)

- b. Blade almost as long as serration, serration usually with 8-15 notches *C. mus* (fig. 7)
- II. Tooth rather short and broad, the head armed on one side with a small barb at the tip and three minutely serrated blades on the other. *Conus regius* belongs to this group (fig. 3).
- III. Tooth small and lacks any kind of serration. The tip is armed with a sharp barb on each side, one being about twice as long as the other. The rest of the tooth is plain, except for a rather large spur at the base. *C. jaspedius* and its forms belong to this group (fig. 1).
- IV. Tooth large, lacking serration; the shaft is cylindrical with a simple base and no spur. The armature consists of two large barbs, one on each side of the tip, and a long backward-pointing process with curved tip. *C. ranunculus* is in this group (fig. 2).

Peile (1939) suggested that the presence of the projecting spur at the base of the tooth might serve to retain the tooth within the proboscis when prey is attacked. However, Kohn (1956) showed that *Conus striatus*, which does not possess the spur, retains the tooth in the proboscis in feeding.

Kohn (1959) showed that the presence of the spur at the base of the cone is generally correlated with feeding on eunicid and other tube-dwelling polychaete worms. Since eunicids burrow in the coral and coral-reef rocks, Kohn suggests that the spur may help the predator in extracting the worm from its burrow. At least one of the Puerto Rican species, *Conus regius*, was found to contain a large number of polychaete bristles in its alimentary tract, and the radula teeth of this species do have spurs at their base. (Table 1 and fig. 3).

About 100 live or preserved cones were available for this study. Notes which may prove of interest are included for each species.

CONUS REGIUS Gmelin

A common species found living under rocks and in coral reefs in 4 to 10 feet of water. The animal is blood red in color. The cones studied ranged in length from 19 mm. to 67 mm. The radula sac contained from 25 to 32 teeth, most of them stained yellowish brown. The teeth increased in length with the size of the shell. In the 19 mm. cone the teeth measured 0.525 mm. in length; in the 67 mm. cone they measured 2.1 mm. The largest variation in size of teeth within one shell was 0.07 mm.

In the 67 mm. cone, the poison gland measured 20 mm. in

length, the radula sac 10 mm. in length, and the tube leading from the poison gland to the buccal mass was 290 mm. long when stretched out.

CONUS MUS Hwass

This is one of the most common cones in Puerto Rico. It is found crawling on rocks and in crevices in a few feet of water. The animal is dark red, speckled with purplish red. The cones studied ranged in size from 15 mm. to 36 mm. in length. The radula sac contained from 32 to 35 teeth, which ranged in length from 0.379 mm. (15 mm. shell) to 1.106 mm. (36 mm. shell). The teeth within the same cone vary little in size, 0.03 mm. being the largest variation observed.

In the 36 mm. cone the poison gland measured 9.5 mm. in length, the radula sac 5.5 mm. in length, and the tube leading from the poison gland was 95 mm. in length when stretched out.

During March, 1959, *Conus mus* was found with egg cases. The cones were in a rock depression, in about 2 feet of water, and the cases were attached to the rock. The egg capsules were light cream colored, rectangular in shape, and measured approximately 10 mm. in length by 7 mm. across. Each case contained over 500 eggs, the majority still in the 1-cell stage, but some had divided into 2 cells, and a few had reached the 4-cell stage.

CONUS JASPEDIUS Gmelin

Most of the specimens used for this study were obtained from shallow dredgings on sandy or mud bottoms. The animal is yellow, speckled with black. The cones ranged in length from 19 mm. to 30 mm. and varied from smooth (without pustulation), to intermediate (some degree of pustulation), to verrucose (pustulose).

The radula sac contained from 52 to 70 teeth. The teeth of these three forms are identical in shape, and the length of the teeth is proportional to the size of the cone, regardless of its form. (See Table 1). This similarity in tooth structure would seem to indicate that *Conus verrucosus* is not a distinct species from *Conus jaspadius*, but rather a genetic form as suggested by Abbot (1958).

Table 1. Comparison of tooth and shell length in smooth, intermediate, and pustulose forms of *Conus jaspedius* Gmelin.

	Shell length in mm.	Average length of teeth in mm.
Smooth	19	0.31
Pustulose	20	0.34
Intermediate	21	0.34
Smooth	21	0.36
Intermediate	22	0.38
Pustulose	26	0.41
Smooth	30	0.44

CONUS RANUNCULUS Hwass

This is one of the rarer species of cones from Puerto Rico. All our information is based on one preserved specimen collected by M. McDowell, on Mona Island, 40 miles west of Puerto Rico. The specimen measured 50 mm. in length and the operculum 11 mm. The animal had a bright orange proboscis, the edge of the mantle was yellow-orange, and the rest of the animal was cream colored, splotted with brown. The periostracum was thin and light yellow in color. The radula sac measured 13 mm. and contained 34 teeth, averaging 5.17 mm. in length.

In this species, the muscle at the base of the tooth is very long and strong.

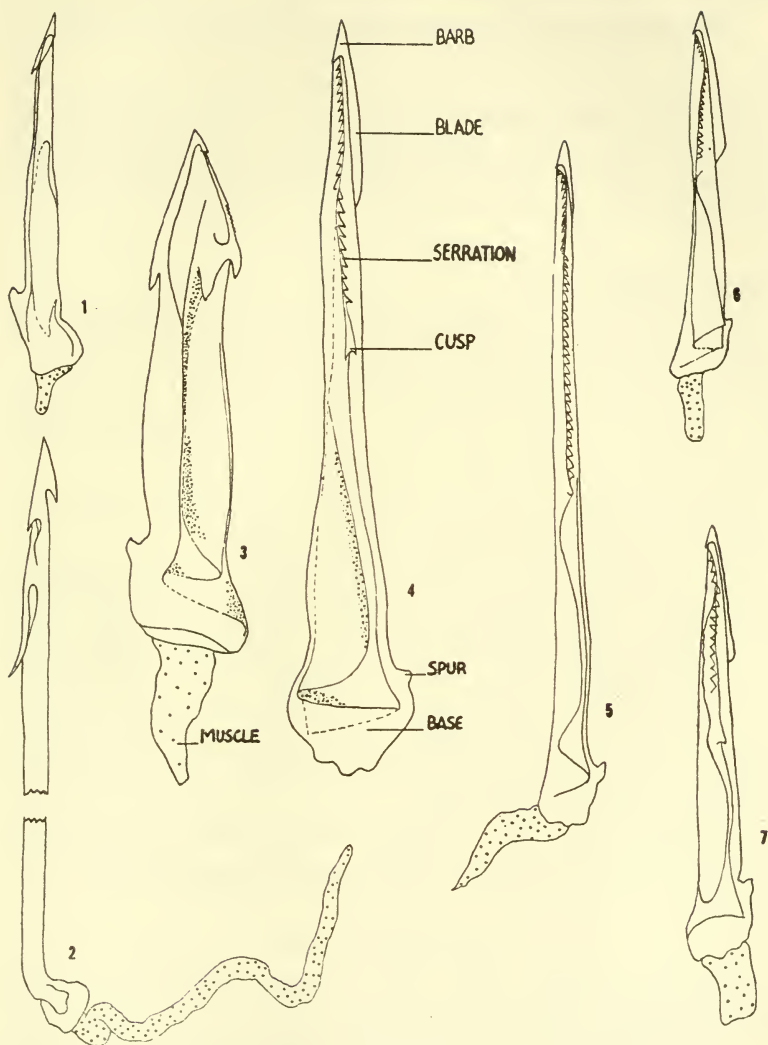
CONUS SPURIUS Gmelin

Dead shells of this species are fairly common on the west coast, where there are reefs offshore. Our studies are based on a freshly-killed specimen, 44 mm. in length, which had a 14 mm. operculum. The periostracum was light brown, thin, flaky, and transparent. The animal was cream-white in color. The radula sac contained 38 teeth, measuring from 1.085 mm. to 1.15 mm. in length.

CONUS DAUCUS Hwass

Like *C. spurius*, dead shells are often found on the beaches, but live shells are hard to find. The animal is bright orange throughout. The tiny black eyes are almost at the tips of the tentacles. The radula teeth measured from 0.995 mm. to 1.20 mm. in length in the 45 mm. shell.

In this species, the muscle at the base of the tooth appears to be weak, since not one of the teeth retained the muscle when



Camera lucida drawings of single radula tooth from 7 species of Puerto Rican cones. 1, *Conus jaspedius* (actual size of tooth .34 mm., extracted from a 21 mm. cone). 2, *C. ranunculus* (tooth 5.17 mm. from 50 mm. shell). Part of shaft omitted in figure because of extreme length. 3, *C. regius* (tooth 2.1 mm. from 67 mm. shell). 4, *C. daucus* (tooth 1.2 mm. from 45 mm. shell). 5, *C. spurius* (tooth 1.15 mm. from 44 mm. shell). 6, *C. juliae* (tooth .63 mm. from 20 mm. shell). 7, *C. mus* (tooth .75 mm. from 30 mm. shell).

they were teased away from the radula sac.

One specimen found at Aguadilla remained alive in a dish of salt water for over 2 weeks. The animal was most active at night. When the shell was placed with the aperture down on the bottom of the dish, the animal would turn a somersault by pushing with its foot until it flipped up in an almost verticle position, with the spire of the shell resting on the bottom of the dish.

CONUS JULIAE Clench

This little cone is usually found on the west and northwest coasts, where there are reefs offshore. Specimens of this species remained alive for several days in the laboratory. The color of the animal is bright orange-red. The specimens studied were 20 and 27 mm. in length. The radula sac contained 20 teeth, which measured from 0.63 to 0.69 mm. in length.

In the 20 mm. cone, the poison gland measured 5.5 mm. in length and the radula sac 2.0 mm. in length.

Acknowledgements: This work was made possible through the kindness of many persons, who donated or loaned their shells to the Institute of Marine Biology for this study. The author is most grateful to Ted and Lois Arnow, F. St. Clair, Merrill Arbuckle, M. McDowell, Genie Garrison, Amy and K. O. Phares, Gordon Usticke, General Merwin H. Silverthorn, Jorge Rivera López, A. J. Ostheimer, 3rd., A. L. Laurence, James and Betty Bradford, and Charles Gover.

Christine Boyce, of the College of Agriculture and Mechanic Arts, University of Puerto Rico, made all the drawings.

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NEW CALIPYRGULA FROM PLEISTOCENE OF TEXAS
AND NOTES ON COCHLIOPA RIOGRANDENSIS

BY A. B. LEONARD AND TONG-YUN HO

Continued studies of the large assemblages of fossil shells from Pleistocene deposits in the Pecos River Valley in southwestern Texas, jointly sponsored by The University of Texas Bureau of Economic Geology and The National Science Foundation (contract number NSF-G3481), have brought to light another undescribed species, here assigned to the genus *Calipyrgula* for reasons which were discussed in a previous paper (Leonard and Ho, 1960). In the course of these studies, both fossil and living examples of *Cochliopa riograndensis* Pilsbry and Ferriss were obtained. We also include in this paper our observations on this little-known species.

CALIPYRGULA CIRCUMSTRIATA, new species. Plate 12, figs. 1-3

Diagnosis: A minute hydrobiid gastropod, having an elongate, narrowly conic, imperforate, or narrowly rimate shell of 6 or 7 rounded whorls; aperture small, ovate, slightly angulate above; peristome simple, slightly reflected over minute umbilicus and adherent to last whorl above; suture simple, well incised; protoconch finely granulose, remaining whorls generally bearing 5 or more narrow spiral ridges of somewhat irregular size and spacing.

Calipyrgula circumstriata closely resembles *C. hibbardii* Leonard and Franzen (1944, p. 19), but the latter lacks the surface sculpture characteristic of *C. circumstriata*. It differs from *C. pecosensis* Leonard and Ho (1960, p. 110) in having fewer whorls, less slender form, and spiral sculpture. From species of *Tryonia*, *C. circumstriata* differs by having spiral, rather than vertical sculpture, and by having well-rounded, rather than shouldered whorls.

Holotype: (Pl. 12, Fig. 1) Catalogue no. 11301, University of Kansas Museum of Natural History, obtained by A. B. Leonard and Tong-yun Ho, 4 June, 1959. Original no.: ABL 1004.

Description of holotype: Shell minute (less than 5 mm. in length), narrowly conic, imperforate, having 7 well-rounded whorls; aperture ovate, narrower and angulate above; peristome simple, slightly reflected over umbilicus and adherent to last whorl above; protoconch of one and one-half whorls finely granulose, remaining whorls bearing narrow, somewhat irregularly spaced spiral ridges ranging in number from 3 on second whorl

to 12 on last; last three whorls having a few indistinct vertical ridges crossing spiral sculpture; extremely fine and numerous vertical growth lines apparent on all whorls save protoconch; suture simple, well incised.

Paratypes: No. 11302, UKMNH. (Plate 12, figures 2, 3). Considerable variation occurs among the several hundred paratypes from the same locality; the extremes are illustrated. Fig. 2 exemplifies the obsolescence of the spiral lines on some shells, while fig. 3 shows another extreme, but relatively rare, variation in which vertical ridges are conspicuously developed. Intergradation occurs among the variants; most shells, however, closely resemble the holotype. Variations in dimensions are illustrated by the following measurements, in millimeters.

	<i>Length</i>	<i>Diameter</i>	<i>Height aperture</i>	<i>Diameter aperture</i>	<i>No. of whorls</i>
Holotype	4.9	2.1	1.5	1.2	7
Paratype (fig. 2)	4.3	1.8	1.3	1.0	6½
Paratype (fig. 3)	3.7	1.4	1.2	0.7	6

Paratypical specimens have been deposited at the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, and at the United States National Museum, Washington, D. C.

Type locality: Late Pleistocene terrace deposits in right bank of Pecos River, one-fourth mile above mouth of Independence Creek, on Chandler Ranch, Terrell County, Texas.

Areal and stratigraphic distribution: We found *Calipyrgula circumstriata* at: the type locality; on W. C. Dunlap Ranch, about 12 miles south-southeast of Sheffield, in Terrell County; and near bridge on U. S. Highway 290, 3 miles southeast of Sheffield, Pecos County, Texas. At the last mentioned locality, a single specimen of *C. circumstriata* was found associated with *C. pecosensis*, although the latter species occurs abundantly in the late Pleistocene terrace along the Pecos River, as far north as northern Reeves County (Leonard and Ho, 1960, p. 112).

Each of the three localities of occurrence of *C. circumstriata* is in the late Pleistocene terrace in which the Pecos River is presently shallowly entrenched.

Inasmuch as *C. circumstriata* has been found in deposits along the Pecos only at places where that river has begun its entrench-

ment in Cretaceous rocks as it approaches the deeply entrenched Rio Grande, we may infer that *C. circumstriata* inhabited the clear, cool, rocky streams characteristic of certain tributaries (such as Independence Creek) of the Pecos River. This inference is strengthened by the observation that at the Chandler Ranch (type) locality, *C. circumstriata* occurs with fossil *Cochliopa riograndensis* Pilsbry and Ferriss; the latter is presently living in Independence Creek. Efforts to find living *C. circumstriata* have not been successful.

COCHLIOPA RIOGRANDENSIS Pilsbry and Ferriss. Pl. 12, figs. 4-7, text figs. 1-4.

Pilsbry and Ferriss (1906, p. 171) described *Cochliopa riograndensis* from shells found at two localities near the Rio Grande, Val Verde County, Texas. The original description was based on "dead" specimens taken from drift debris. For this reason, they gave no information about habitat, or about anatomical details of radula and operculum. To our knowledge, neither the radula nor the operculum has been described and figured. We deem it advisable, therefore, to contribute our observations to a further knowledge of this little-known species.

Shortly after the discovery of fossil shells of *C. riograndensis* (UKMNH. no. 11343) at the type locality of *Calipyrgula circumstriata*, we found nearly 30 specimens of living *C. riograndensis* in Independence Creek, near the bridge on Texas Highway 349, about 16 miles south of Sheffield, in Terrell County, Texas (UKMNH. no. 11636, 4 June, 1959, original no. TYH 30) and no more than a mile from the place where the fossil shells were collected. The snails were living in relatively sluggish water about six inches deep in the clear, cool, fast-flowing stream. *C. riograndensis* was here restricted to the edge of the stream, and was fairly abundant under cobbles of limestone, logs, and in aquatic vegetation. Associated with *C. riograndensis* were *Lymnaea bulimoides techella* (Haldeman), *Gyraulus similis* (Baker), *Physa anatina* Lea, and *Ferrissia shimekii* (Pilsbry). To our knowledge, this occurrence of *C. riograndensis* is a northern extension of its previously known range.

Operculum (Pl. 13, fig. 1): Horny, thin, roundly ovate, all sides regularly rounding upward to a semiarculate apex; whorls 5, the last about triple the width of penultimate whorl, inner

whorls narrower and increasing regularly in width; sculpture consisting of coarse unequidistant, obliquely radiating growth lines crossed by very fine spiral lines that are visible only on the last half of the last whorl; nucleus small, circular, more or less granular, placed about $6/13$ the distance from base to apex, somewhat toward the left side; attachment to operculigerous lobe indicated by a thickening about a third of the distance from border to nucleus; thickening raised above the general level of the operculum; greater diameter from 0.8 millimeters to 1.3 millimeters.

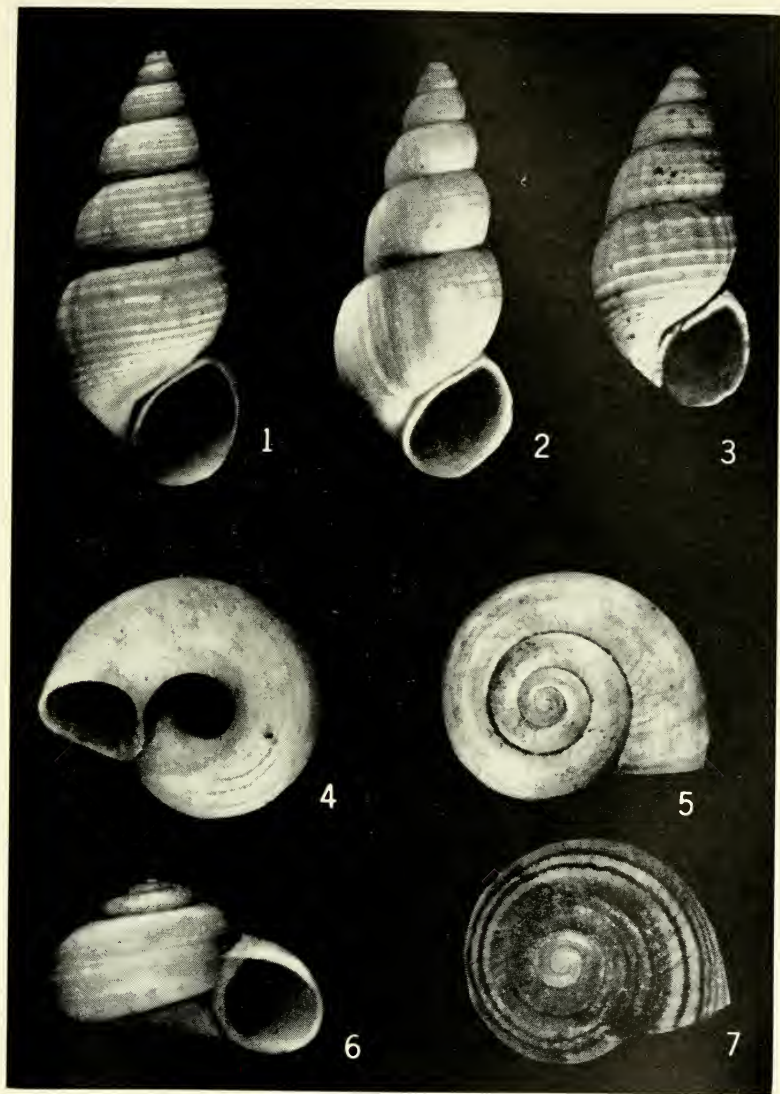
Measurement of figured specimen: greater diameter, 1.3 mm.; lesser diameter 1.1 mm.

Radula (Pl. 13, figs. 2, 3, 4): Central tooth (fig. 2): Width about twice height; lateral angles produced and sharply triangular; ventral margin having large, triangular process extending from base; lateral ridge large, wide, having two basal denticles, anterior one larger than posterior; reflection wide and low, having 11 sharply elongate cusps, central cusp about three times as wide as lateral cusps, reaching nearly $2/3$ distance from dorsal margin to ventral margin; lateral cusps smaller, gradually increasing in size toward center. Lateral tooth (fig. 3): Body slightly wider than high, having sharply rounded lobe extending from inner basal part of body; large, U-shaped, pit-like depression in center of body; peduncle almost twice as long as body, gradually narrowing toward end, having elongate ridge parallel with long axis, but displaced toward outer margin; reflection wide and low, bearing two inner cusps, one large central cusp and four outer cusps, all cusps sharply elongated and diminishing in size toward margin of tooth. Inner marginal tooth (fig. 4): Falcate, having long and narrow body; peduncle spatulate, less than twice length of body, bearing elongate centrally placed ridge parallel to long axis and branching near base of body; reflection wide and low, bearing 20 to 30 fine, sharply elongate cusps; cusps near central portion of reflection relatively large and acute, those on lateral margin becoming smaller.

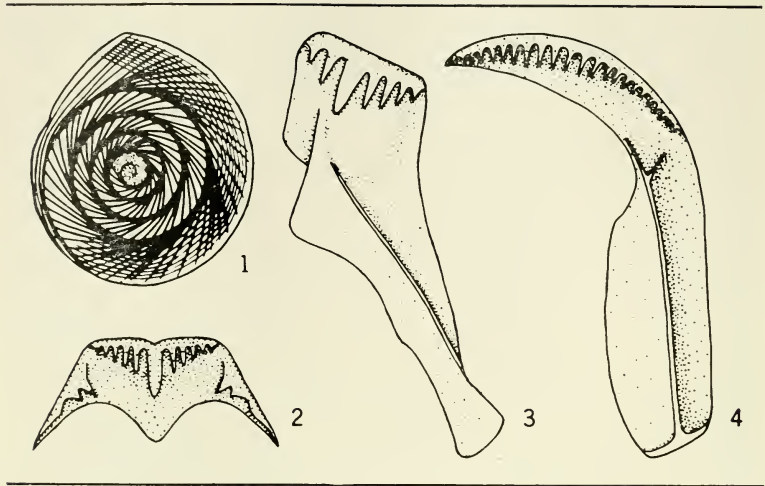
Measurements of figured radula in microns

Central tooth. Width	32
Height	16
Length of cusp row	20
Lateral tooth. Height	58
Length of cusp row	20
Marginal tooth. Height	51
Length of cusp row	24

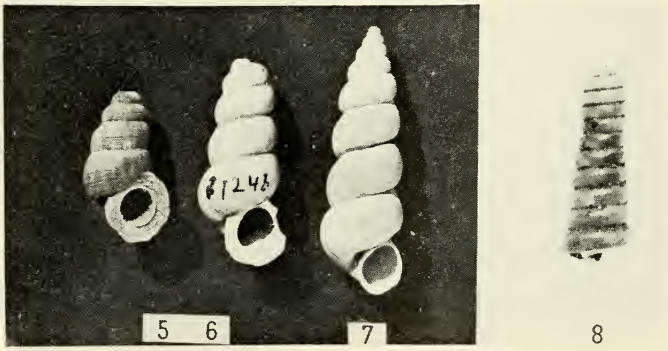
We found no significant differences between the fossil shells of *Cochliopa riograndensis* (Pl. 12, figs. 4, 5, 6), and those from living individuals (Pl. 12, fig. 7). The spiral color bands on



Figs. 1-3, *Calipyrghula circumstriata* Leonard & Ho: 1, holotype shell. 2, 3, paratypes from same locality, to show extremes of variation in size, proportions and surface sculpture. Figs. 4-7, *Cochliopa riograndensis* Pilsbry & Ferriss: 4-6, fossil shells. 7, apical view of shell from living animals.



Figs. 1-4, *Cochliopa riograndensis* Pilsbry & Ferriss: 1, outer view of operculum, $\times 26$. 2-4, radular teeth ($\times 1000$): 2, central; 3, lateral; 4, inner marginal.



Figs. 5-7, *Choanopoma radiosum* (Morelet): normal adult (5) and two elongate freaks (6, 7). Fig. 8, *Coelocentrum fistulare* (Morelet) nuclear whorls.

shells from living snails differ in number and in width; a few individuals had broad colorless bands on the ventral aspect of the shell. The protoconch is invariably colorless, and lacks also the spiral ridges characteristic of the remaining whorls. Color bands are, of course, absent on fossil shells since the epiostracum is not preserved, and the spiral ridges are often faint, as they are on the figured specimen.

Several of the living examples of *C. riograndensis* from Independence Creek contained embryos in advanced stages of development; these varied from 30 to 50 in number in adult snails.

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NON-MARINE MOLLUSKS FROM BRITISH HONDURAS

BY FRITZ HAAS AND ALAN SOLEM
Chicago Natural History Museum

Outside of the few records listed by von Martens (1890-1901), no non-marine mollusks have been reported from British Honduras. The availability of some material collected by Ivan T. Sanderson in 1940 and W. D. Thomas in February, 1959, has prompted this short list. Mr. Thomas collected at the Río Frio Cave East, about two miles from Augustine on the Mountain Pine Ridge, Cayo District, British Honduras. Mr. Sanderson collected at several localities as listed under the specific names. The material is all deposited in Chicago Natural History Museum, with a set of duplicates of Mr. Thomas's shells in the Museum of Comparative Zoology, Harvard.

Most of the species are common Guatemalan forms, but surprisingly, some species previously known only from the Bay

Islands off Honduras (see Ancey, 1886 and Richards, 1938) were represented. Some peculiarly incrustated fresh-water shells are reported on separately (Haas, 1959). A few forms are figured as an aid to future workers.

Pomacea belizensis (Crosse and Fischer). Stann Creek Valley.

Pomacea ghiesbreghti ghiesbreghti (Reeve). Kate's Lagoon.

Neocyclotus dysoni dysoni (Pfeiffer). Río Frio Cave, Kate's Lagoon, Bokowina.

Choanopoma (C.) *rigidulum* (Morelet). Río Frio Cave.

Choanopoma (*Colobostylus*) *radiosum* (Morelet). (Pl. 13, figs. 5-7) Río Frio Cave.

Two non-decorticated, elongate freak specimens are shown with a normal individual.

Choanopoma (*Choanopomops*) *largillierti* (Pfeiffer). Chetumal.

Helicina (H.) *flavida* (Menke). Río Frio Cave.

Helicina (*Oxyrhombus*) *amoena* (Pfeiffer). Río Frio Cave, Double Falls, Bokowina.

Lucidella (*Poeniella*) *lirata* (Pfeiffer). Río Frio Cave.

Pyrgodomus simpsoni (Ancey). Río Frio Cave.

Described from Utila Island, Honduras, by Ancey (1886: 253-254), this species differs from the Guatemalan *P. microdina* (Morelet) only in having a more angulate periphery. Possibly they are only subspecifically distinct.

Pachycheilus (P.) *planensis* Lea Río Frio Cave.

Living examples were collected from the stream issuing from the cave and mummified specimens (see Haas, 1959) were found inside the cave.

Pachycheilus (*Glyptomelania*) *obeliscus* (Reeve). Sibun R., tributary of Eastern Branch, Cayo District (W. D. Thomas!).

Synopeas beckianum (Pfeiffer). Río Frio Cave.

Leptinaria (L.) *fordiana* (Ancey). Río Frio Cave.

Leptinaria (L.) *lamellata* (Potiez and Michaud). Stann Creek Valley.

Spiraxis (*Volutaxis*) *sulciferus* (Morelet). Río Frio Cave.

Streptostyla thomsoni (Ancey). Río Frio Cave.

Streptostyla dysoni (Pfeiffer). Río Frio Cave.

Euglandina sp. Río Frio Cave.

Euglandina cylindracea (Philippi). Chetumal.

Hyalosagda haldemaniana (C. B. Adams). "British Honduras."

Unless Sanderson's locality is in error, this species has probably been imported on plants from Jamaica.

Microceramus (M.) *consisus* (Morelet). Chetumal.

Brachypodella (B.) *subtilis* (Morelet). Río Frio Cave.

Coelocentrum (C.) *fistulare* (Morelet). (Pl. 13, fig. 8). Río Frio Cave. The opportunity is taken to figure the nuclear whorls.

Orthalicus princeps crossei Martens. Río Frio Cave, Double Falls.

Drymaeus (D.) *alternans honduranus* (Pfeiffer). Río Frio Cave, Kate's Lagoon.

Bulimulus (B.) *corneus* (Sowerby). Chetumal.

Averellia (*Trichodiscina*) *coactiliata* (Deshayes). Río Frio Cave, Chetumal.

We are indebted to Mr. W. Donald Thomas of Balboa, Canal Zone, for the opportunity to study this material and to Mr. A. H. Anderson, Archaeological Commissioner of British Honduras, for information concerning the Río Frio Cave site.

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QUANTITATIVE SAMPLING

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In this paper, the term quantitative is used in the sense of the statistician and not in the lay sense of simply large numbers of organisms taken in the field.

Mollusks are collected, as are all other organisms, for two reasons only. First, and of no interest here, they are collected simply as curiosities of natural history. Second, they are collected for the purpose of studying all, or some aspect of the population. In this latter kind of collecting the only practical method of collecting is by means of samples. The samples represent observations. In so far as it is practicable to do so, and only in so far as practicable, samples should be collected quanti-

tatively. Actually, an ideal quantitative sample must fulfill three fundamental criteria (cf. Simpson and Roe, "Quantitative Zoology" (1939) :

1) Collections must be made from a single, well-defined population only.

2) Collections must include all the variations within the population.

3) The variations must occur in the sample with the same relative frequency they have in the whole population.

Good sampling starts with a definition of the population to be sampled, and good collecting involves as complete a collection of all the elements in the definition as possible.

The first criterion of the ideal sample is commonly achieved. It is easy to limit our collections to a single, well-defined population. All that is necessary is to specify the geographic area, to include all the ecological habitats, and to limit the material to be collected to a feasible group. The crucial part of this criterion is the exact description of the population to be studied.

The second criterion is a product of technique. This ideal may or may not be achieved by a persistent collector with nimble fingers and a supply of sampling devices. The problem encountered in resolving this criterion is the ability to recognize objectively when effective satisfaction of the criterion has been realized. Subjectively, no one can recognize whether or not this criterion has been fulfilled.

The third criterion is the area in which we move from biology into statistics. We cease dealing with natural populations as such and begin working with frequencies. The statistics of quantitative analysis fall beyond the scope of this paper.

The first criterion of the ideal sample is almost wholly biological, and the biologist can resolve it to his complete satisfaction. The third criterion is almost wholly statistical, and the statistician can resolve it to his complete satisfaction. But the criterion falling between these two appears to be in a never-never land of inarticulation. The collector who works intensely goes home convinced that he has collected all the species with all their variations that occur within the defined population. The statistician who receives this material for processing is inclined to doubt that this has been accomplished. This, apparently, is in accord with the experience of each.

In any quantitative sampling, there are only three basic approaches. These are: 1) samples based on a fixed and predetermined unit of area, 2) samples based on a fixed and predetermined unit of mass, and 3) samples taken through a fixed and predetermined period of time. Everything else is only a modification of one or more of these.

Plankton can be measured volumetrically. Time can be used for organisms that can be trapped or for organisms that will invade and populate a sterile surface. However, these are restricted samples. The techniques based on area are the only ones that are applicable to all kinds of organisms.

Two years ago the molluscan population of a New Jersey river was sampled. The area collected was a shaded, rubble-bottomed, low-gradient stretch of a small coastal river. Although one pool had a depth of about 15 feet the stream held a littoral fauna only. Rooted aquatic vegetation occurred in extensive patches. The stream was not polluted, although some organic enrichment was evident. From the collected area, the following 13 species of mollusks were taken:

Campeloma decusum	Gyraulus parvus
Amnicola limosa	Physa heterostropha
Goniobasis virginica	Laevapex fuscus
Lymnaea humilis	Elliptio complanatus
Pseudosuccinea columella	Anodonta cataracta
Helisoma trivolvis	Sphaerium transversum
Helisoma anceps	

At this location on the eastern seaboard in the latitude of New Jersey, any experienced collector would assume that all the species of the defined (molluscan) population that might be anticipated were, in fact, found. The only exception might be *Pisidium casertanum*.

The sample was taken on an areal basis. The collection was made so that material from every ecological habitat was included. The qualitative collecting was quantitatively tempered by inserting a time factor. Each habitat was collected until 30 minutes elapsed without the addition of a species not previously taken.

If a purely quantitative sample had been sought, only two techniques, or a modified combination of them, could have been used. The first would be the quadrat method; the other the transect method. However, the physical structure of the

collected area would have eliminated the proper use of either of these.

In quantitative collecting, the sampling devices must be uniform. No sampling device ever invented would have taken a uniform and constant sample from this locality because the physical structure of the stream militated against this. Collecting was done until the collectors were satisfied subjectively that no further additions to the fauna could be found.

It is significant to note that the accumulated field experience of most collectors is such that the possibility of designing a single piece of equipment that would uniformly sample even a small percentage of all the areas collected in a field season is virtually nil. This is a very real handicap for absolute quantitative sampling. Because of this, all collecting must, of necessity, be biased. Furthermore, because of this, it is theoretically impossible to take samples that are amenable to quantitative techniques.

Aside from the inability to take quantitative samples because of mechanical limitations, there is another aspect that must be considered. This is the concept of randomness. The heterogeneity of the environment and the behavioral characteristics of each species are opposed to random collecting. A good quantitative sample must be chosen at random, otherwise bias is introduced. Actually natural waters are not disposed at random and aquatic organisms are not dispersed at random. There are real causes behind their occurrence and distribution. This is a built-in bias that cannot be overcome.

An experienced biologist would anticipate the presence of the species actually collected from this locality, but he certainly would not seek them by random collecting. He would look for them in the habitats where they live. The three species of clams, along with *Campeloma decisum*, are burrowing forms. They can only be taken by digging into the substrate. The limpet, *Laevapex fuscus* is virtually sedentary. Conversely, the other pulmonate snails are quite peripatetic in their foraging, as are *Amnicola limosa* and *Goniobasis virginica*. Some of these tend to be gregarious while others tend to be solitary. The lymnaeids do not hesitate to leave the water and forage on sloping mud banks, etc. Yet they certainly must be included in the fauna of

an aquatic habitat. Evidently the collector resolves the second fundamental criterion of the ideal sample to his own satisfaction, but he does not do this quantitatively in a statistical sense, and his data should not be used to resolve the third criterion.

To sample, randomly, a population composed of burrowing, sedentary and peripatetic species, as well as solitary and gregarious species, and have the results mean anything quantitatively, is a highly dubious procedure.

The second fundamental criterion for the ideal quantitative sample cannot be mechanically realized as a standard practice. Quantitative samples can only be taken if the population is defined with those restrictive terms which, by their very nature, eliminate the total faunal complex from the population. A complete fauna cannot be included in the definition.

The collector who wishes to handle his material quantitatively, and the statistician who wishes to analyze such material, must keep two thoughts constantly in mind. First, collections produced by competent qualitative collecting will yield approximate quantitative data. This approximation is sufficiently accurate for use in a textual description of the population. Second, a perfect sample in the quantitative sense is impossible of collection because the introduction of bias in sampling cannot be avoided, and this defeats the concept of randomness.

In addition to these very severe limitations, it is worth mentioning that statistical analyses are very time-consuming, and therefore expensive. Furthermore, only very rarely do statistical analyses reveal facts that are not already apparent from really competent qualitative collecting. Usually such studies do not produce results that are sufficiently advanced over qualitative work to justify the time and expense involved.

MOUNTING MINUTE RADULAE

By R. D. TURNER

Museum of Comparative Zoology

The preparation of radula mounts of minute snails (i.e., those 5 mm. and less in size) is generally a time consuming, extremely tedious task, and, in the process of moving the radula from one solution to another, it is often lost. This is particularly

frustrating when only one or two specimens are available. The following technique is practically foolproof and produces excellent results.

If the specimens are preserved in alcohol, the animal can often be extracted from the shell using a minuten pin mounted in a glass rod and hooked at the point. Using the slide on which it is planned to mount the radula, start at the left and place in a line, first a small drop of KOH or NAOH, then a drop of water, a drop of 70% alcohol and a drop of polyvinyl alcohol mounting medium. Place the specimen in the NAOH to soften the animal until it is clear but can still be moved without falling apart. The length of time required for this varies with the material and it must be watched under the scope. The specimen is then slid from the NAOH to the drop of water to remove the base, then on to the drop of 70% alcohol for a couple of minutes. From here you can slide it into the drop of mounting medium. The radula can be seen inside the head and can be easily teased out by using "minuten pin dissecting needles." Move the radula to a clear spot and, if sufficiently large, one possibly may dissect a portion of the radula in the medium. The operculum, if present, can also be removed easily and safely and moved to a clear spot. The remainder of the animal can then be removed from the mounting medium if desired.

If the animal cannot be removed from the shell, only two small drops need be added to the slide so that, beginning at the left, there is a drop of *weak* acid to dissolve the shell, a drop of water to get rid of the acid and then a drop of weak base to soften the animal and continuing as before.

By this procedure, the entire process may be carried through to completion without ever lifting the specimen or taking your eye from it. To this point, all work is done under the highest power of a binocular dissecting scope. Once the cover slip is in place, the remainder of the slide can be wiped clean and the radula can be examined under the high power of a compound microscope. Since PVA does not harden rapidly, one can, with a needle and light pressure on the cover glass, rotate the radula and examine it in various positions while making illustrations. When the study is completed, the slide should be ringed with duco cement or fingernail polish. Staining the radula usually

is not necessary when using PVA mounting medium but if this is desired, a drop of acid stain can be added to the line just prior to the drop of PVA. This procedure has reduced a process, which may run into hours devoted mainly to groping for lost radulae, to less than 20 minutes and so far, since using this method, I have not lost a specimen.

LAND SNAILS FROM CENTRAL SOUTH FLORIDA

BY DRUID WILSON

The area around Lake Moody, two miles north of Frostproof in Polk County, is in a part of the Central Highlands or Highlands Ridge of Florida locally called "the Ridge." Originally, the open pine woods of the high surrounding hills graded in places and at slightly lower elevations into black-jack oak (*Quercus laevis*) woods and near the lake into a narrow zone of palmetto thickets. Most of the area is now planted in citrus groves. The soil is mapped as Norfolk fine sand (Fowler and others, 1932, Soil map of Polk Co.), but some minor variation is evident. The soil is noticeably lighter wherever black-jack oaks predominate. During the last 25 years, changing cultural practices doubtlessly have caused fluctuations in the populations of the snail species. The soil is naturally deficient in calcium and application of such materials as basic slag and dolomite to the soil of citrus groves appears to affect favorably some of the species. Use of basic slag in the 1930s was never really common, but dolomite is now almost universally used. Desultory spraying with lime-sulfur solution or dusting with sulfur in these depression years probably had little or no effect on species living in citrus groves. Present day intensive spraying with oil emulsions and compounds of copper and zinc and application of copper sulfate to the soil apparently are injurious to some of the species or inhibit the growth of their food.

Polygyra cereolus (Muhlfeld). The species was first noticed in 1940 in a young citrus grove adjacent to the highway near a roadside fruit stand. All the individuals examined have been of the "normal" form *Polygyra cereolus carpenteriana* (Bland) except one within the size range of the historically typical and

larger form *Polygyra cereolus cereolus* (see Pilsbry, 1940, p. 584-586) having a diameter of 12 mm. Since 1940 the species has spread to groves nearby and along the highway which has a base and shoulders of limestone. Pilsbry (p. 589) reports that *Polygyra cereolus* occurs on calcareous soils and *Polygyra septemvolva* Say on acid soils in the same districts. Establishment of a spreading colony of *cereolus*, in an area of naturally acid soil deficient in calcium, some distance from any reported occurrence, is probably due to chance introduction and the presence in the treated citrus grove soil of sufficient calcium carbonate. All the specimens examined have the internal lamina characteristic of *cereolus*. The data given for Hubricht's conclusions (1953, p. 116) that "the internal lamina is not a valid specific character, and *P. septemvolva* and *P. cereolus* are one species" are unconvincing and directly opposed to the data and opinions on the two species given by Pilsbry (1940, p. 582-590).

Praticolella jejuna (Say). A high, pine timber habitat for this species was noted long ago (Simpson, 1885-89, p. 66; Webster, 1892). It apparently is the only land snail endemic on the highest hills of the Ridge district. Before most of the land was cleared, the species was rare and never found in colonies, but it is now common in citrus groves. In the early 1930s, it was excessively abundant in two citrus groves several miles apart in which the soil had been treated with basic slag. Either dolomite now used is less favorable, or current spraying practices and the use of copper sulfate on the soil affect the species adversely.

Praticolella bakeri Vanatta. No living specimens have thus far been found, but "bones" have been collected in two small areas. A few in a black-jack oak woods one half mile northeast of Lake Moody, now cleared, and in greater numbers about 1.5 miles further north in a citrus grove bordering on woods of the same kind.

Euglandina rosea (Férussac). This species is probably native to the thickets of the lake edge and has also been taken around houses. None of the individuals collected exceeds the measurements given by Pilsbry (1946, p. 194) for the small ecological variety *E. rosea minor* (W. G. Binney) which according to Pilsbry inhabits dry places.

Zonitoides arboreus (Say). Specimens have been found living

only in the crowns of the ornamental palm "*Cocos plumosa*," where it is sometimes abundant. This restricted ecological niche, sometimes as much as 20 feet above ground, has little except temperature in common with its surroundings. It supports along with the snails an amazing community of which blattids, sow bugs, earthworms, and ants are the more obvious members.

Pupisoma dioscoricola (C. B. Adams). Formerly present in vast numbers in citrus trees, these minute snails are now common only in trees not subject to repeated spraying.

These species are the only land mollusks, except an unidentified slug, that I have found in the area during a period of over 35 years.

I am grateful to Dr. J. P. E. Morrison of the U. S. National Museum for identifying the specimens of *Zonitoides arboreus* and *Pupisoma dioscoricola*.

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SOME OCEANIC SUB-TIDAL OYSTER POPULATIONS

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The oyster, *Crassostrea virginica*, is usually regarded as an estuarine organism, that is, one which lives in estuaries, where seawater is mixed with fresh water. It thrives especially well under estuarine conditions, forming natural beds. Churchill (1920) placed the optimum salinity for oysters between 14

and 28 o/oo. Several reasons have been suggested for this characteristic distribution. A greater quantity of planktonic food is available to oysters there than in a more marine environment. Fresh water flowing into the estuary may bring elements that are important to the oyster's successful completion of its life history, such as copper which has been credited with an important role in settling (Prytherch 1934). Probably more important is the inability of many oyster enemies to live in brackish waters. The boring sponge, *Cliona celata*, and the oyster drill, *Urosalpinx cinereus*, are two such oyster enemies that are barred from upstream beds by reduced salinities.

In high salinity waters of the southeastern states, oysters are usually restricted to the intertidal zone, the deep water beds occurring in areas of reduced salinity. This intertidal distribution has been attributed to the selection of this zone by oyster larvae (Galtsoff & Prytherch 1927), or to a flow of chemical elements from fresh water that stimulates larvae to attach in the intertidal zone (Prytherch 1934), or to the failure of oyster spat to survive at lower levels. Lunz (1943) blamed the boring sponge, *Cliona celata*, for eroding shells below the low tide mark to such a degree that development of natural oyster beds in this lower zone is prevented. Similarly, Chestnut and Fahy (1953) suggested that the predation of oyster spat by the oyster drill, *Urosalpinx cinereus*, offers a partial explanation for this distribution of oysters in high salinities.

This report describes an unusual occurrence of oysters below the intertidal zone in coastal North Carolina waters. Certain environmental factors which appear to be involved are discussed.

Observations: A study has been made of marine organisms attached to metal wrecks near the outer coastline in the vicinity of Cape Hatteras, North Carolina. The location of each collecting station is indicated in Figure 1 and described below.

1 — *Overlook*. This unidentified wreck is located 100 yards from the beach 2 miles north of the Pea Island National Wildlife Refuge Headquarters, formerly the Pea Island Lifesaving Station. Its boiler stands above high tides; other sections are exposed only by lowest tides.

2 — *Rodanthe*. The wreck of Landing Ship 232, 1948, is located in the surf on the beach 600 yards south of Chicamacomico

Lifesaving Station. The ship is largely intact, with super-structure extending well above mean high water.

3 — *Waves*. The wreck of a landing ship, 1948, is located 50 yards from the beach opposite the village of Waves. The ship is broken into sections, several of which project above mean high water.

4 — *Salvo*. An unidentified wreck is located 80 yards from the beach opposite the village of Salvo. Several pieces extend above mean high water.

5 — *Ocracoke*. Wreck of the Steamer "Ariosto," 1899, is located 300 yards from the beach 2 miles southwest of the ferry slip at the eastern end of Ocracoke Island. Its mast extends less than two feet above mean low water.

6 — *Portsmouth*. Wreck of the Freighter "Miget," 1952, is located 300 yards from the beach 3 miles south-southwest of Portsmouth village. A large section extends above mean high water.

Oysters were collected in numbers at the four stations situated north of Cape Hatteras. However, no living oysters were found on the Ocracoke wreck. At the Portsmouth wreck, living oysters and many dead shells of *Crassostrea virginica* were present. While oysters are present on wrecks in the Hatteras area, they were scarce on wrecks south of the Cape.

On the wrecks at Rodanthe (#2) and Waves (#3) living oysters were abundant, attached to metal parts below the low tide level. Immediately above them was a zone of blue mussels, *Mytilus edulis*, which formed the lowest truly intertidal zone. Only abnormally low tides would expose any oysters in this habitat; most are never exposed. Oysters occupied most of the surfaces in this subtidal zone, with only occasional openings where the corrosion of underlying steel or the erosion of oyster shell by boring sponge had so weakened attachment that a cluster of oysters had been dislodged. This layer of oysters provides attachment for some organisms and crevices suitable for the colonization of other species. Oyster distribution on other wrecks followed these general lines, with the principal segment of the population occupying subtidal surfaces, and only a minor representation in intertidal zones. The intertidal individuals were restricted to the lowest fringe of the intertidal zone.

On the Portsmouth wreck (#6), *Crassostrea virginica* did not constitute a large part of the community. Oysters have successfully attached to this wreck and survived, but they are far outnumbered by specimens of the horse oyster, *Ostrea equestris*. On these southern wrecks, *O. equestris* effectively replaces *C. virginica*, both in numbers and in its contribution to suitable substrate for the colonization of other organisms. On wrecks north of the Cape, individuals of *O. equestris* occur, but in less abundance than on the Ocracoke and Portsmouth wrecks.

Discussion: An analysis of the various environmental factors helps explain this unusual distribution.

PHYSICAL FACTORS: Animals attached to these wrecks are regularly exposed to the action of surf, its aeration, its tendency to dislodge insecurely attached forms, and to the abrasive effects of suspended sand. At each station oysters are exposed to oceanic conditions—relatively stable high salinities and moderate temperatures that change gradually with the seasons. Neither salinity nor temperature exceed the tolerances of the oyster. Temperature gradients along the coast have been recorded for the Cape Hatteras region (Parr 1933, Wells & Gray 1960), but they seem unlikely to be directly responsible for permitting sizeable populations of oysters north of the Cape and none or few south of the Cape in comparable situations. Instead, temperature may have an indirect effect by controlling the distribution of oyster enemies. Physical factors do not provide a satisfactory explanation for the observed distribution.

BIOLOGICAL FACTORS: A large number of oyster enemies are recognized in different parts of the world (see Korrington 1952). They include competitors for food and space, and organisms that invade the oyster meats or shell, as well as the more obviously effective predators.

Competitors: Mussels (*Mytilus edulis* and *Brachidontes exustus*) and barnacles (*Chthamalus* and *Balanus* species) occur in abundance on these wrecks. By sheer numbers, they would make attachment to a firm substrate difficult for oyster larvae. However, they are usually attached at higher levels on the wrecks than are the oyster populations, and the oysters are successful in maintaining themselves in spite of their presence. The horse oyster, *Ostrea equestris*, is much more abundant on

wrecks south of Cape Hatteras. Its abundance might present serious competition with *Crassostrea virginica* for suitable attachment.

"Invaders": Apparently the same species of boring sponge (*Cliona* species) are present on wrecks south of the Cape as on wrecks north of the Cape. There is a greater abundance of boring sponge colonies, however, on southern wrecks. This is probably a reflection of the greater abundance of *Ostrea equestris* there, for this species of oyster may be more heavily infested by boring sponges, as Wells (1959) has reported at Beaufort, N. C. Shells of oysters are usually securely attached to the wrecks, otherwise surf action would pull them loose. Apparently *Cliona* has not been so effective in preventing the development of sizeable populations of oysters here as Lunz (1943) found in waters of comparable salinities in South Carolina.

Predators: Although starfish of the genus *Asterias* are important enemies of oysters in Long Island Sound (Galtsoff & Loosanoff 1939), few starfish have been found and those only on the Rodanthe wreck where the oyster population is best developed. Apparently, starfish have little effect upon these populations of oysters.

Lunz (1947) has pointed out the importance of the blue crab, *Callinectes sapidus*, as a predator of oysters in South Carolina. Numbers of large blue crabs were often observed feeding among organisms attached to the wrecks. They were present on wrecks both north and south of the Cape, and were observed feeding directly on oysters at the Rodanthe wreck. Although crabs are abundant in this habitat and they prey on oysters, the distribution of these oyster populations is not related to the distribution of crabs.

Predaceous gastropods, recognized oyster enemies in many parts of the world, are represented on these wrecks by two species: *Thais floridana*, the Gulf oyster drill, and *Urosalpinx cinereus*, the Atlantic oyster drill. In the Gulf of Mexico, *Thais floridana* is a serious predator of oysters (Burkenroad 1931, Butler 1954). In the Hatteras area, this species was collected in numbers from the two wrecks south of the Cape, but none were found north of the Cape.

Although individuals have been recorded from Chincoteague,

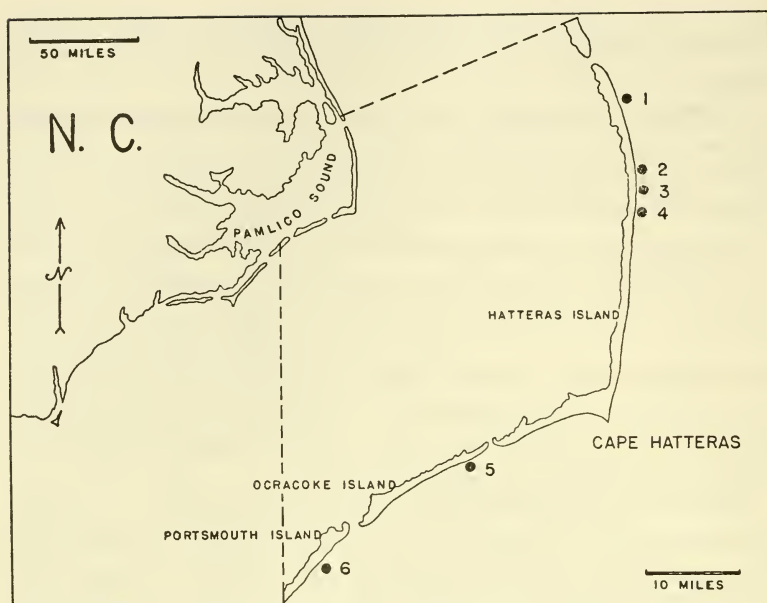


Fig. 1. Eastern North Carolina with the Cape Hatteras region enlarged to show the location of collecting stations.

Virginia, *Thais floridana* does not occur in numbers north of the point of Cape Hatteras. The populations on the southern wrecks were producing typical clusters of egg capsules in early June, 1959, indicating that they are capable of reproduction in this locality. Planktonic larvae of this species could be carried northward, but apparently have not populated the northern wrecks. Conditions seem to be unfavorable for reproduction north of this point. Probably temperature gradients in the region of Cape Hatteras are responsible for preventing the successful colonization of otherwise suitable habitats to the north. Apparently the scarcity of oysters on wrecks south of the Cape can be correlated with the occurrence of sizeable populations of this predator.

The Atlantic oyster drill, *Urosalpinx cinereus*, is recognized as the most important enemy of oysters in many areas (Carriker 1955), but because it cannot tolerate low salinities, oyster beds in the upper part of many estuaries are free of this pest. The isolation from drills provided by low salinities permits the

development of large natural oyster beds in these areas.

Urosalpinx cinereus was abundant on the Ocracoke wreck (#5), while none were found on the other wrecks studied. Apparently here predation by this species has prevented the maintenance of a sizeable oyster population below the low tide mark. On wrecks north of Cape Hatteras, however, subtidal oyster populations survive and thrive in the absence of this species.

Of the major oyster enemies, only drills are absent on wrecks north of the Cape. All other species mentioned—mussels, barnacles, oysters, sponges, starfish, and crabs—have pelagic larvae which could be carried by currents to a newly-foundered wreck where they could attach and produce a thriving population. The pelagic larvae of *T. floridana* are similarly capable of reaching new wrecks, but are apparently barred from penetrating north of the Cape. On the other hand, instead of pelagic larvae, *Urosalpinx cinereus* produces a "crawl-away" larva which emerges from its egg capsule as a miniature of the adult. Crawling constitutes the chief means of dispersal, although Carriker (1957) has shown that these larvae may attach to moving objects or seaweed or be carried by the surface film. The present-day distribution of this species is attributed to its unintentional introduction to new areas by man (Carriker 1955). *Urosalpinx cinereus* has been recorded from hard bottoms off the North Carolina coast (Pearse & Williams 1951, Chestnut, in Carriker 1955), and has been collected from hard bottom off Ocracoke Inlet. In view of the exposure of these wrecks to wave action, crawling over the bottom seems the most likely means of invasion. However, this species would have to traverse miles of sand bottom to reach these wrecks from known hard bottoms. The possibility of individuals reaching one of the wrecks would be very small, but the probability of a successful invasion would increase with time. The Ocracoke wreck now populated by *U. cinereus*, where oysters no longer thrive, is one of the oldest wrecks. It has been subject to such invasion for sixty years.

It appears as though the abundance of oysters on wrecks north of Cape Hatteras can be correlated with the absence of oyster drills, which is in turn correlated with the age of a particular wreck. In this case, the isolation from oyster drills provided oysters on these wrecks is similar to the isolation from drills

provided oysters in upstream estuarine oyster beds through the agency of a salinity barrier. In both instances, oysters may flourish in the absence of drills. The presence of mussels, boring sponges, and crabs has had little obvious effect on these oyster populations.

The abundance of *Ostrea equestris* on the southern wrecks may be explained by a preference of these gastropod drills for *C. virginica* as their prey, and their avoidance of *O. equestris* as prey. Such a preference between these two oysters is exhibited by another predaceous gastropod, *Fasciolaria hunteria* (Wells 1958).

The presence of *Thais floridana* on the southern wrecks suggests that it is partly responsible for the observed scarcity of subtidal oysters there. Probably this species also contributes to restricting oysters to intertidal situations in higher salinities in the southeastern states. Unlike *Urosalpinx cinereus*, *Thais floridana* can quickly populate new wrecks by means of its pelagic larvae, thus making the likelihood of oysters establishing subtidal populations in the ocean very small south of Cape Hatteras.

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SUMMARY

The unusual occurrence of subtidal populations of oysters in the ocean has been noted on five wrecks on the outer coast in the region of Cape Hatteras, North Carolina. Comparisons were made with wrecks where oysters are scarce. The occurrence of oysters has been correlated with an absence of the oyster drills, *Thais floridana* and *Urosalpinx cinereus*, which are apparently most important in limiting oysters to intertidal situations in high salinities in some areas.

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NOTES ON THE PRODUCTION OF EGGS IN *ONCOMELANIA NOSOPHORA* AND *O. FORMOSANA*¹

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In a previous publication (Roth and Wagner, 1957) the anatomy of the reproductive system of *Oncomelania nosophora* (Robson) has been described. The present investigation was pursued to determine the changes taking place as the egg develops while passing through the reproductive system of the female.

For this study, snails which had been reared under laboratory conditions of near constant temperature and light were used. The snails were fixed in Bouin's embedded in paraffin, serially sectioned at 6 to 10 microns and stained usually with Harris' hematoxylin and tryosin.

The anatomy of the female reproductive system of *Oncomelania formosana* (Pilsbry & Hirase) was studied and found to be similar to that of *O. nosophora*. Wagner and Chi (1959) have shown that these two species will cross with each other producing fertile offspring. The development of the oöcyte appears

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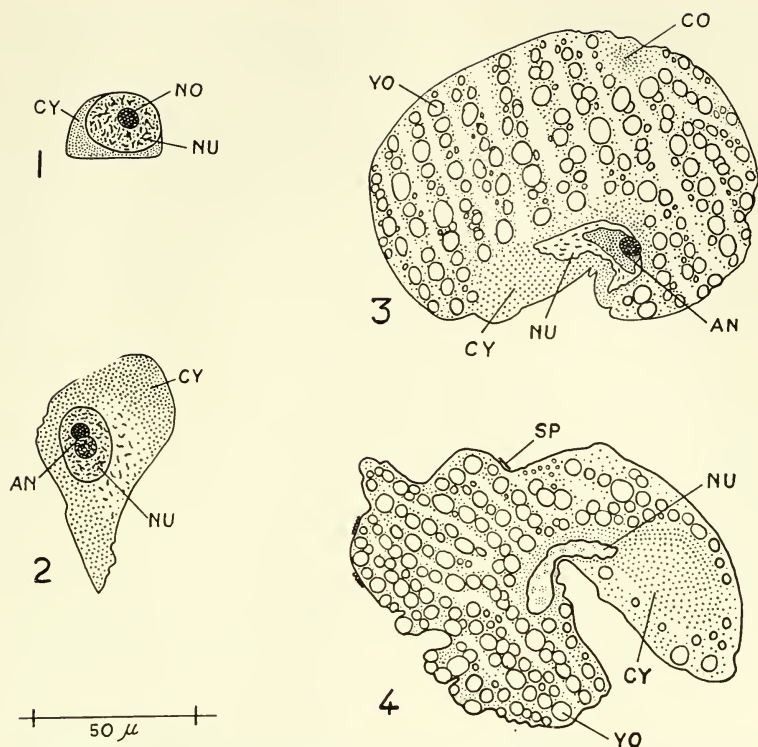
to follow the same process in both *O. nosophora* and *O. formosana*. The following description is based on *O. formosana*.

The early stages up to the completion of the formation of the yoke take place in the ovary. The first indication that one of the cells along the wall of the diverticulated ovary is becoming an oöcyte is an increase in size especially of nucleus along with the appearance of a large nucleolus. The cytoplasm which is at first reduced, finely granular and strangely basophylic (Figs. 1 and 2), becomes acidophylic as the oöcyte reaches full size. At this stage, it is composed mainly of yolk globules of various sizes tending to be arranged in chains (Figs. 3 and 4). These are enclosed in a vitelline membrane and since the oöcyte takes on many varied shapes obviously the contents as well as the surrounding membrane are very pliable. In many of the medium and large oöcytes, the nucleolus, which in earlier stages appears single, becomes an amphinucleolus (Fig. 2) with both parts basophylic; however, one part does not stain as deeply, and, in Mollory's connective tissue stain, one half is red while the other is blue.

The following changes usually take place in the parts of the oviduct which lies between the ovary and the gonopericardial diverticulum; however in several specimens these changes were noted in the ovary, while in others these changes were not noted even in the oöcytes found near the gonopericardial diverticulum.

The nucleus, which previously was nearly spherical, now begins to flatten conspicuously. The amphinucleolus also flattens but maintains its two characteristic parts. A large depression develops at the outer surface of the oöcyte (Figs. 3 and 4). The nucleus becomes associated with this depression and usually lies against it, but is separated from the vitelline membrane by a thin dense layer of cytoplasm, which apparently is devoid of yolk (Figs. 3 and 4). In some instances on the side of the oöcyte opposite from the depression and nucleus can be found a small mass of cytoplasm, also devoid of yolk (Fig. 3). This may correspond to the mass of cytoplasm found at the vegetative pole of the egg of *Lymnaea stagnalis* L. as described by Raven (1945).

The oviduct proceeds anteriorly beyond the gonopericardial diverticulum, passes by the opening of the seminal receptacle



All figures at same magnification. Abbreviations used: AN, amphinucleolus; CO, cytoplasm found on side opposite from nucleus; CY, cytoplasm; NO, nucleolus; NU, nucleus; SP, sperm; YO, yolk.

1, section of young oöcyte of *O. formosana* found along wall of ovary. 2, section of more mature oöcyte of *O. formosana* found along wall of ovary. 3, section of large oöcyte of *O. formosana* found in ovary, composite of two serial sections. 4, section of large oöcyte of *O. formosana* found in accessory gland (composite of 3 serial sections).

and bursa copulatrix, and then goes lengthwise through the elongate, accessory gland opening into the mantle cavity. Eggs are very rarely found in these anterior portions of the oviduct. To enhance this possibility, 80 male-female pairs were isolated in as many petri dishes provided with mud, filter paper, and maple leaves. The dishes were inspected for the presence of eggs five to six times a week. We found that the females, that lay any eggs, tend to lay for periods of a few days, which alternate with longer periods when no eggs are laid. Those females which appeared to be most active reproductively were examined at

frequent intervals throughout the day to try and ascertain when each was about to lay an egg, and when such was suspected the female was immediately placed in the fixative. The shell was crushed to permit rapid penetration of the fixative.

The eggs of *O. nosophora* are laid singly and are enclosed in a layer of mud, with which entire faecal pellets can be found. Some of the specimens were fixed when the female appeared to have selected a site for the building of the egg capsule; others were fixed after the building of the egg capsule had actually started. The female used her proboscis to lay the foundation for the mud capsule. The rest of the process of egg laying was not observed.

Of the females involved in this study 28 were fixed at a time when oviposition was suspected. They were serially sectioned, stained and examined for the presence of eggs. Eggs were frequently found in the posterior part of the oviduct, but in no instance could they be found in the parts of the reproductive system anterior to the gonopericardial diverticulum. The mantle cavity of each of these snails was also examined for the presence of eggs, but none could be found there. Possibly the last steps in the production of an egg are rapid ones.

While pursuing another study on the function of other parts of the reproductive system, an egg was found in the posterior region of the accessory gland of *O. formosana*. The specimen in which this egg was found had been raised in isolation until 24 hours prior to fixation when it had been mated to a male. Apparently egg laying already was taking place. The oöcyte (Fig. 4) appears to be of the same size and general structure as those found in the first part of the oviduct. The nuclear contents are not so distinct. No extra layers are present on the outside of the oöcyte such as are found in eggs that have been laid. Several sperm are attached to the surface of the oöcyte while many more are in close proximity to it. No sperm appeared to be definitely inside the oöcyte at this stage.

The presence of eggs in the accessory gland of *Oncomelania* has not been previously reported, to the writers' knowledge. Dundee (1957) who studied *Pomatiopsis lapidaria* (Say) which belong to the same subfamily, reported that no eggs were found in the anterior parts of the oviduct in many specimens collected

from the field. She did state that a fellow worker found an egg in a specimen, and mentioned a report on it which has not been published yet.

Since the oöcyte found in the accessory gland had a maximum length of less than 150 microns while Chi and Wagner (1957) have found the egg, including its mud capsule, had an average diameter of 1.0 mm., obviously much must be added before the egg is completed. About a $\frac{1}{3}$ of this addition consists of the mud capsule. The rest is composed of a clear, spherical, gelatinous mass in which the small, whitish oöcyte is readily detectable. The origin of this gelatinous mass could not be determined in our study. Finding an oöcyte in the anterior part of the accessory gland might help elucidate this question. Perhaps fixation of specimens earlier or later than was done in this study might produce more positive results; also both Abbott (1946) and Dundee (*l.c.*) suggested that the eggs are laid at night. This cycle might be used as an aid in obtaining eggs in the anterior part of the oviduct. This was not a factor in our study since the constant source of light, under which the snails were kept, eliminated the possibility of such a cycle.

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ECOLOGIC NOTES ON PUERTO RICAN MOLLUSCA

By FRANK B. GOLLEY

AEC, Savannah River Project,
Department of Zoology, University of Georgia

While on an ecological expedition¹ to study the functional ecology of the montane rain-forest and mangrove forest communities in May, 1959, I was able to make several observations on molluscan ecology. Although some of these notes may be repetitive, they are offered here in hope that they may prove a not unwelcome contribution to the ecology of neotropical malacology. One objective of my study was to determine the biomass or weight of the herbivores and carnivores in the community. To do this, a count necessarily was made of all animals in representative plots within the forests, at various periods during the day and night. During these very intensive examinations of the habitat, mollusks were encountered and the following observations recorded.

Montane Rain-Forest: Observations were made in two locations within the montane rain-forest. These were both within the Luquillo National Forest, on the north-east end of the island of Puerto Rico. The first study area was on the eastern front of the mountains above the Sabana Ranger Station, at an altitude of 340 meters, in a relatively undisturbed region of the forest. The study area was representative in that it included both ravine and ridge habitats. Vegetation here included the dominant tabunuco (*Dacryodes excelsa*) and palms, tree ferns, lianas, and bromeliads characteristic of tropical forests.

The second study area was located within the mountain massif, at El Yunque. Here, at the transition between the montane rain-forest and the sierra palm forest (altitude approximately 700 meters) a moist ravine was investigated. Tabunuco and tree ferns were present at this location, and the sierra palm (*Euterpe globosa*) increased greatly in density. A few additional observa-

¹Supported through a grant from the Rockefeller Foundation to the Institute of Marine Science, University of Texas. I am indebted to Dr. H. T. Odum, expedition leader, and Mr. Ronald Wilson, Institute of Marine Science, for their assistance in making the observations which form the basis of this paper. I am also grateful to Dr. J. P. E. Morrison for identifying the mollusks and for his suggestion that I prepare these notes on molluscan ecology, and to Dr. Grace J. Thomas, University of Ga., for critically reading the manuscript.

tions were also made in the mossy forest or elfin woodland, crowning the mountain peaks, in the Mt. Brittian area.

Rainfall is quite heavy in these regions, averaging at study area one, 135 inches per year, and increasing as one ascends the mountains. Temperature is very constant, averaging 23° C. during the day, and dropping to approximately 19° C. at night.

At the Sabana study area, mollusks were observed in tree trunks and in the thin leaf litter overlying the soil. The long, thin *Nenia tridens* appeared to be the dominant tree snail on the ridges. Close examination of ten tabunuco trees of different diameters indicated that the ratio of *Nenia* to the other abundant snail, *Pleurodonte carocolla*, was seven to one. In the ravine, the round *Pleurodonte* increased in abundance and appeared to be codominant with *Nenia*. In the leaf litter, *Megalomastoma* (*Neopupina*) *croceum* was most abundant. The average number of snails on the ground was 0.4 per square-meter, and on the trees, 1.8 per tree. In this community, snails, when considered either on the basis of numbers or biomass per square-meter, are less abundant than are ants or Orthoptera.

On El Yunque, *Pleurodonte* was decidedly the most abundant snail and was present on most tree trunks and on the concrete walls of cabins. As many as a dozen individuals could be collected within 7 feet of the ground on a single palm tree. Over 100 individuals were collected and measured in this locality. The major diameters of the shells (exclusive of lip of aperture) are shown below. If shell diameter is a crude approximation of the

	Midpoint of diameter class in mm.											
Diameters	18	21	24	27	30	33	36	39	42	45	48	51
No. of snails	1	0	3	1	4	4	6	1	6	23	35	17

age of the snail, these data indicate that there may be continual additions to the population. Diameters of a few of the *Pleurodonte* were also taken at study area one; however, none of these measured less than 40 mm.

In the mossy forest on Mt. Brittian (approximately 1000 meters altitude) one square-meter quadrat was carefully inspected for its animal fauna. Because of exceptionally heavy rainfall, continual erosion occurs and the soil is washed from between the tree roots. The result of this erosion produces a thick and very dense mat of roots on top of the mineral soil and rocks. This

root mat is approximately 6 cm. in depth. In addition, the trees in the mossy forest are covered with a thick growth of mosses and lichens. The combination of epiphytic covering on the tree trunks and the root mass on the ground surface appears to produce an adverse environment for invertebrate life. No snails were found on the quadrat or on the trees bordering the trail through the forest. And only 3 small insects were collected in the square-meter plot.

Mangrove Forest: The mangrove forest was studied at La Paquerre, the location of the Laboratory of Marine Biology, University of Puerto Rico. The study area in the forest was located approximately 20 meters from the open water, where the vegetation was completely composed of red mangrove, *Rhisophora mangle*. At the time of the study, only one-half of the study area was submerged at high tide. Techniques similar to those used in the rain-forest were used in the mangrove forest. Three one-square-meter quadrats were observed at various periods during the day and night and all animals seen were counted. Samples of the thin layer of mud and the mangrove peat beneath the mud were handsorted for residents. Finally, tree trunks, prop roots, and leaves were carefully examined for animals.

The snail, *Melampus coffeus*, was the most numerous animal present on the surface of the mud. An examination of 9 square-meter plots revealed that 54 snails were present per square-meter. *Melampus* was the second most important animal in the community on the basis of biomass (.254 grams dry weight/m²), the crab, *Uca mordax*, having the greatest biomass (.425 grams dry weight/m²).

The *Melampus* could be observed during the day, at low tide, on surfaces of decaying leaves and on the mud. However, during the night, at high tide, many of these snails had ascended the young seedlings of *Rhisophora* or the prop roots of mature trees. For example, in one night quadrat, 26 individuals of *Melampus* were observed on seedlings, 2 on prop roots and 7 on the ground surface; in another 15 were on seedlings, 22 on prop roots and 4 on the mud.

No large *Melampus* were observed in the study area, all specimens being less than 6 mm. in total length. Very small examples

of *Melampus* were abundant in every plot examined. Unless the large adults were present in some portion of the forest not studied, the size distribution of *Melampus* would indicate two generations, with a turn-over in the snail population once every two years.

NOTEWORTHY RECORDS OF WYOMING MOLLUSCA

By DOROTHY E. BEETLE

Fourteen species in 9 genera have been found during the past 5 years of intensive collecting in Wyoming.

Pupoides hordaceus (Gabb) was collected on the sandstone cliffs overlooking Guernsey Reservoir, elevation 4400 feet, in Platt County. The area is very dry, supporting only scattered Yellow pine and cedar. *Yucca*, grasses, and a few herbaceous plants form a scant ground cover. A single fresh, dead, specimen of *P. hordaceus* (D. Beetle 56-289) was found in a crevice in the rocks. A broken *Gastrocopta*, probably *G. armifera* (Say) (D. Beetle 56-298) was sorted out of drift at the edge of the reservoir.

Pupilla syngenes dextroversa (Pils. & Vanatta) was collected in Hot Springs County, 5 miles east of Thermopolis, on the road to Lysite. In the leaf mold of cottonwoods and shrubs growing along a dry stream, 5 specimens (D. Beetle 57-374) were found. The soil was fine red sand, overlying sandstone. The elevation is 4400 feet.

Vertigo ovata Say was found by Paul Freytag in Albany County along the banks of the Little Laramie River near Centennial, elevation 7800 feet. The snail was found in willow debris, and brought to the author for identification.

Vallonia excentrica Sterki was discovered at two localities in Wyoming. At Thermopolis, some individuals (D. Beetle 57-370) occurred under sedimentary rocks on the hillside opposite the hospital. This is a south facing slope, dry, supporting cedar, a few grasses and shrubs. The elevation is 4350 feet. In Sheridan County this mollusk was found in willow leaves along the Tongue River at Ranchester, elevation 3775 feet. (D. Beetle 57-430).

Vallonia costata (Mueller) (D. Beetle 56-276) was collected at Ayers Natural Bridge near Douglas, Converse County. La

Prele Creek flows through a hollow where it has carved out a natural arch in the sandstone. Cottonwoods, box elder, willows, grape, and poison ivy grow in dense thickets. *V. costata* was living in the leaf mold and grass of the caretaker's lawn. The elevation is approximately 4850 feet.

Lymnaea (Radix) auricularia (L.) was picked up by Dr. George Baxter at Alsop Lake, Albany County. This is a shallow, alkali pond on the Laramie Plains, elevation 7000 feet. The author has found *L. auricularia* in two Colorado localities; Woodland Park in Teller County, and in the lake at City Park at Walsenberg, Huerfano County. Where this introduced mollusk has become established, it is very abundant.

Lymnaea (Galba) doddsi (Baker) was discovered at three localities along the western slopes of the Big Horn Mountains. Dry Fork Canyon above the Elkhorn Ranch, near Shell, has a tiny creek tumbling down it. Near the mouth of the canyon, at an approximate elevation of 4300 feet, the creek disappears into a small hole in the rocks. It falls through a cave in which it has hollowed out a basin in the sedimentary rock. The walls and floor of the cave are overgrown with moss. The *Lymnaea* (D. Beetle 58-219) was around the edge of the basin and in the moss. It also occurs in Washakie County, in Leigh Canyon, near the Fish Hatchery at an elevation of 4450 feet. The snails were crawling on sedimentary rocks at the edge of the small creek (D. Beetle 58-157), and on grass along a slough farther up the canyon (D. Beetle 58-147).

Lymnaea (Galba) dalli Baker was found living in Barber Lake in Albany County at an elevation of 8700 feet. This is a tiny, shallow, silt bottomed pond. The animals were crawling on aquatic vegetation near the shoreline (D. Beetle 50-358).

It was previously reported (Beetle, D. 1957. Nautilus 71 (1): 12-22.) that *Gyraulus articus* (Müller) was found in Leigh Lake, Teton County. Additional material, identified now by Dr. Dwight W. Taylor as *Promenetus umbilicatellus* (Cock.), has been discovered in Yellowstone Lake as well as in Bighorn, Johnson, Goshen and Albany Counties. The mollusks are usually crawling on vegetation in shallow muddy areas. Inclusive elevations range from 4300 to 9200 feet.

Three species of *Pisidium*, identified by Rev. H. B. Herring-

ton, can be included in Wyoming records.

Pisidium compressum Prime was noted by J. Henderson at Evanston many years ago. Recently it has been found in Goshen County in a backwater of the Springer Reservoir, elevation 4250 feet. The clay bottom contained many clams (D. Beetle 56-158). Empty shells were found in drift in Guernsey Reservoir, and in the Laramie River in Albany County. In Laramie County it was found in two ponds in the south eastern corner of the county.

Pisidium ferrugineum Prime was found in the mud of a beaver pond on Libbey Creek near Bear Lake in Albany County (D. Beetle 55-537). The elevation is approximately 9100 feet.

Pisidium nitidum Jenyns (D. Beetle 56-130) was collected in a beaver pond on Texas Creek at the Williams Ranch near Tie Siding, Albany County, elevation 7750 feet. It occurred in similar situations in Carbon County, both on South Bruiser Creek near Ryan Park (D. Beetle 56-91), and near Baggs (D. Beetle 54-404).

Physa skinneri Taylor, described from the Berends fauna of the Pleistocene, was collected in Yellowstone Lake by Dr. A. A. Beetle. This small *Physa* was living on vegetation and rocks in shallow water around the shoreline.

The author wishes to acknowledge the assistance of the Wyoming Chapter of the Society of Sigma Xi for two grants-in-aid that were used in studies of the molluscan fauna of the Big Horn Mountains.

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HUGH WATSON

1885-1959

With the death of Hugh Watson on 21 January, 1959, England lost one of its most meticulous and experienced malacologists, one whom it will be very difficult to replace for a long time.

Born in Newcastle-on-Tyne on 1 June, 1885, Hugh Watson was educated privately, and later read the Natural-Sciences Tripos at Trinity College, Cambridge, where, after a First in Part I in 1910, his health unfortunately deteriorated. Possessed of private means, he devoted the rest of his life to the study of Mollusca, and lived a very retired life in Cambridge.

In his early days, while he was still capable of travel on the continent, he collected widely both marine and non-marine Mollusca, but later he concentrated almost entirely on the study of non-marine gastropods. He was equally interested in both anatomy and shell form, as is shown by many of his papers. Among British Mollusca he was especially interested, early on, in such genera as *Vallonia* and *Vertigo*, while later on he became mainly interested in the Zonitidae, especially in the British species of slugs, although his publications ranged widely. But his interests extended far beyond this, especially to the study of certain African genera of Mollusca, notably the Planorbidae. In fact, his opinion was continually being consulted by malacologists from all over the world with whom he maintained a voluminous correspondence.

He was equally interested in problems of nomenclature and a series of papers on the correct names for the British non-marine Mollusca were published in 1943. Almost all of the names he suggested have been adopted in the latest British census. At the time of his death, he had just finished an exhaustive enquiry into the correct names for the European species of *Viviparus*.

To a lesser degree, he was concerned with the history of British species discovered by the study of the Mollusca of Pleistocene deposits and was always hoping for the discovery of new records both fossil and living, especially in the east of the country, of species found in adjacent parts of the continent. Unfortunately, his ill health prevented him from looking for these himself, although the care with which he studied doubtful Pleistocene specimens submitted to him was largely instrumental in

the establishment of several new British records.

Because of his retired life, Hugh Watson was not known personally to many other malacologists. He worked with extraordinarily great care, was fundamentally modest about his own knowledge, and would only commit himself after an exhaustive consideration of all literature and data bearing on the subject. He would not tolerate careless work by anyone, and would go to great pains to ensure that any work submitted to him for approval was as thorough and as accurate as his detailed knowledge could make it. This passion for accuracy made him sometimes a little unpopular with impatient prospective authors, but it was completely offset by the kindness which he showed in devoting much of his valuable time to their problems and instruction.

By his will, Hugh Watson left his specimens and his library to the University of Cambridge as well as a considerable sum of money for the furtherance of malacological research.

A list of his publications has been published in *Arch. Molluskenk.* 88:77-78.—B. W. SPARKS, University of Cambridge Dept. Geography, England.

NOTES AND NEWS

JAMES ZETEK. 1886-1959—James Zetek died June 2, 1959, at his home in Panama City. He married in 1914, and they are survived by a daughter, Ella Zetek, of Ecuador. Mr. Zetek was born Dec. 12, 1886, in Chicago, Illinois, and graduated from the state university in 1911. He went to the Canal Zone in the same year as entomologist for the zone's Sanitary Department, and later served similarly the Republic of Panama, which (1915-17) bestowed on him gold medals and a National Grand Prize. He also was connected with the Board of Health Laboratory and the U. S. Department of Agriculture. He helped found the scientific laboratory of Barro Colorado, in Lake Gatun, and became its curator in 1923. The island was set aside as a natural park in 1943, and from 1941 until near the time of his death he was Resident Manager of the Canal Zone Biological Area. (Cf. *Smithsonian Rept.* for 1947: 126-151).

Although primarily an authority on termites, he also was

interested in mollusks and contributed much of the material that was described by Dr. Pilsbry in 1926, as *Scolodonta zeteki* commemorated. Among Mr. Zetek's own publications on mollusks are:

1918. The Mollusca of Pratt, Champaign and Vermillion Counties, Illinois. Trans. Ill. Acad. Sci. 11:151-182.

1918. Los moluscos de la República de Panamá.

1931. (With H. A. Pilsbry). A Panamic *Cyrenoida*. Naut. 45:69, pl. 3, fig. 4.

1934. A new *Drymaeus* from Barro Colorado Island, Panama Canal Zone. Naut. 47:93-94, pl. 13, fig. 1. (*D. pilsbryi*.)

1936. (With R. A. McLean). *Hiata*, a new genus of the family Pholadidae from the Pacific at Panama, with a description of a new species. Naut. 49: 110-111, pl. 8, figs. 1-4.

—H. B. B. and STEWART H. JADIS.

AMERICAN MALACOLOGICAL UNION.—The 1960 meetings will be held August 9 to 12, in the Redpath Museum of McGill University, in Montreal, Canada. Rooms will be available in the Royal Victoria College dormitories. A field trip to Mont St. Hilaire is planned.

ROBERT ROBERTSON appointed Assistant Curator of mollusks at the Academy of Natural Sciences of Philadelphia—Dr. Robert Robertson, who has recently received his degree from Harvard University working under Dr. Clench, has been appointed to the staff of the Academy. His doctorate thesis was on the ecology of the marine mollusks of Bimini, Bahamas. At the Academy, he plans among other things to monograph the Indo-Pacific Phasianellidae and to continue work on Bahamian marine mollusks. He would welcome the loan or gift of specimens of *Tricolia* and *Phasianella* from the Indo-Pacific—R.T.A.

PUPOIDES INORNATUS Vanatta was collected in Larimer County, Colorado, along Route 287 opposite the turnoff to Red Feather Lakes. A limestone ridge is exposed some two hundred feet above the highway. It is a dry situation; a few cedar grow on the rocks, along with poison ivy and grasses. The *Pupilla* were found alive in the crevices and on the undersides of loose rock. (D. Beetle 53-74). —DOROTHY E. BEETLE.

VALLONIA PERSPECTIVA Sterki in Maryland.—On June 28, 1959, Leslie Hubricht and the writer visited Elliott Island, Dorchester

County, Maryland, to collect land shells from this isolated station. From an Indian shell heap, over 20 species of land shells were secured, mostly dead, but the most interesting discovery was the collecting of live juvenile and adult *Vallonia perspectiva* Sterki. This small snail has only been previously reported from the coastal plain by Dr. Pilsbry who collected specimens near Atlantic City, New Jersey, in August, 1909 and May, 1910 (Naut. 25:35). This station no longer exists (Land Mollusca of North America, Vol. 2, pt. 2, p. 1033, footnote).—RALPH W. JACKSON, Route No. 1, Cambridge, Maryland.

ZACHRYSLA PROVISORIA (Pfr.) in Homestead, Florida.—Dr. G. W. Dekle, entomologist of the State Plant Board of Florida, sent several specimens of this species which had been collected alive by P. E. Briggs and J. H. Knowles on November 10, 1959. Apparently this Cuban land snail will shortly become common over much of southern Florida where suitable situations occur. It probably is being distributed on plants, either as eggs in the soil about their roots or as young snails on the plants. As far as I know, no species in *Zachryslia* is considered a pest in Cuba. They feed mainly at night, probably on dead vegetation. (See also Naut. 73:76, 1959)—W. J. CLENCH.

PUBLICATIONS RECEIVED

TWO NEW SPECIES of west North American marine gastropods. By Rudolf Stohler. Proc. Calif. Acad. Sci. 29 (11): 423-444, 10 figs. 1959.—*Astraea (Uvanilla) rupicollina* and *Macrarenia coronadensis* are described and exquisitely figured as new from Lower California.—H. B. B.

PLEISTOCENE MOLLUSCAN FAUNAS of the Humboldt deposit, Ross County, Ohio. By Martin B. Reynolds. Ohio J. of Sci. 59:152-166. 6 figs. 1959.—Mainly on stratigraphic grounds, this fresh-water deposit is considered to be of "early" Wisconsin age.—H. B. B.

LAND AND FRESHWATER MOLLUSKS of Great and Little Inagua, Bahama Islands. By William J. Clench. Bull. Mus. Comp. Zool. Harvard 121:29-53. 1 pl., 1 map. 1959.—*Eutrochatella klinei*, *Drymaeus bahamensis*, subsp. *salina* (noun!), and *Cerion (Maynardia) ericksoni* are new.—H. B. B.

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